DESIGN, CONSTRUCTION, OPERATION OF METAL-WORKING AND ALLIED EQUIPMENT

MACHINERY

JULY, 1943

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DEPARTMENTS

The aircraft industry is now the biggest and most important in the United States—biggest and most important because successful prosecution of the war hinges mainly upon the strength of Allied air power. On account of the magnitude of the aircraft industry, MACHINERY is devoting two special issues this year to airplane production. The July number describes advanced methods in the plants that build the planes themselves; the August number will supplement this production information with articles describing processes in plants that turn out engines, propellers, and turbo-superchargers for "powering" the planes that are winning the war.

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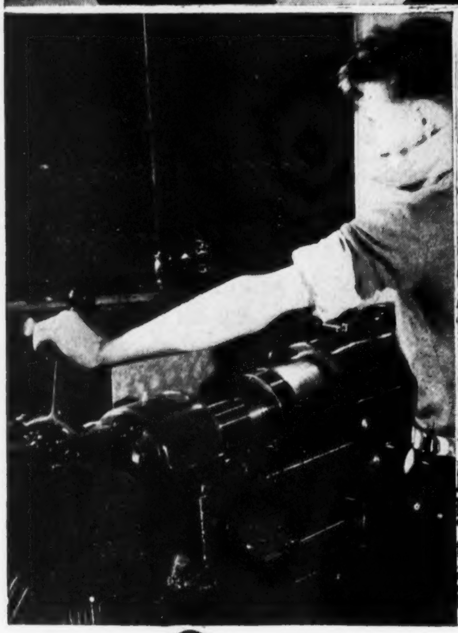

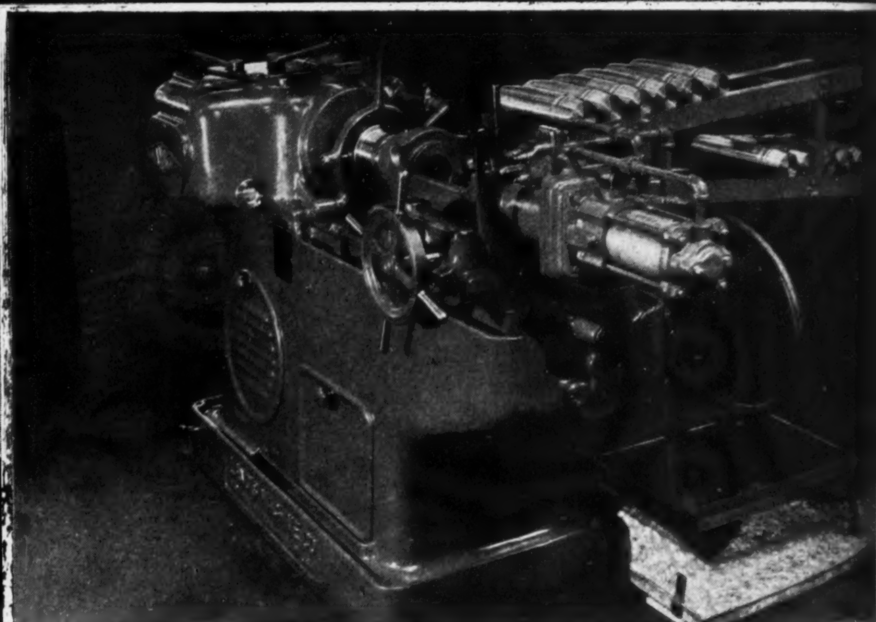

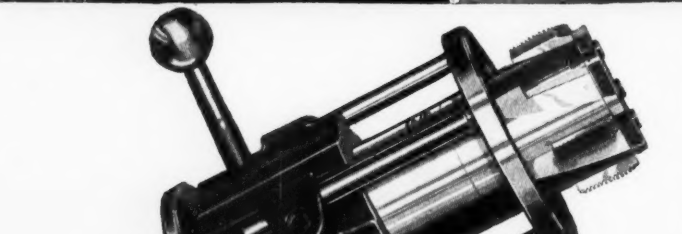

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The United States today is producing more airplanes than the rest of the world—enemies and Allies combined! Attainment of fantastic goals has been achieved because of the phenomenal production strides made by the aircraft industry. Latest methods developed in airplane plants to meet the unprecedented war-time demands are featured in this issue of MACHINERY, while new practices in airplane-engine and propeller plants will be described in a second Aircraft Production Section to be published in August MACHINERY.

MACHINERY

Volume 49 JULY, 1943 Number 11

The Curtiss

TRANSPORTS TROOPS AND WAR

By P. N. JANSEN, General Manager
Airplane Division, Curtiss-Wright Corporation

Building the Largest Twin-Engine Transport in the World Presents Problems Quite Different from Those Met in Small Fighter-Plane Construction. Some of the Curtiss-Wright Production Methods That are Helping to Meet the Critical and Ever Growing Need for Cargo Planes are Described in this Article

Commando

MATERIALS TO FIGHTING FRONTS

ONE of the most spectacular accomplishments of the American war effort has been the establishment of air transport service to all parts of the world—Britain, Africa, and the Near East, Alaska, Australia, India, and China. Shuttling back and forth over this far-flung network of air lanes, American cargo planes are carrying men and materiel in ever increasing quantity. The submarine menace in the Atlantic, the need for strongly fortifying Alaska, and the severing of the Burma Road have made it clear that air cargo transportation must be utilized to the fullest extent.

Early in 1940, the Curtiss-Wright Corporation completed the construction of America's largest twin-engine transport, a plane designed primarily for commercial airline use. In 1941, the United States Army, after exhaustive tests, adopted this plane (the CW-20) for transporting troops and vital war equipment to our far-flung battlefronts.

The current war model of this plane—the Curtiss Commando (C-46)—is equipped with two Pratt & Whitney 2000-H.P. engines, has a wing span of 108 feet, and is slightly more than 76 feet long. As shown in the heading illustration, the large hull can accommodate fully armed infantrymen, together with such equipment as jeeps, light field artillery, ammunition, spare engines, propellers, etc. In addition to the spacious fuselage, there are belly compartments for the storage of smaller cargo items. The Commando has a weight of approximately 14 tons when empty and 22 1/2 tons when loaded. Late in 1941, it crossed the Atlantic from the United States to Britain in nine hours and forty minutes, non-stop.

The very size of this plane alone would indicate that production efficiency lies in the direction of utilizing sub-assembly operations extensively and in carrying these along as far as possible before final assembly takes place. Thus, the fuselage is made up of five sub-assemblies, which are largely completed, from a structural standpoint, before they are spliced together. These five units are the nose section, forward section, center-panel section (to which the two wings are attached), aft section, and tail section.

CURTISS

Fig. 1. This Fixture is Designed to Enable Work to be Done on the Inside and Outside of the Fuselage Section Simultaneously. The Upper Section will Later be Spliced to a Lower Section to Form a Complete Sub-assembly

In Fig. 1 is shown an assembly of the center upper forward section of the fuselage nearing completion. This fuselage unit is first assembled as an upper and a lower section, and these are then spliced together to make a complete sub-assembly. The workers employed in the assembly work, which consists of fitting, drilling, and riveting, are mostly women. The holding fixture is designed to enable work to be done on the inside and outside of the fuselage section simultaneously. The complete lofting of all skin stampings facilitates rapid assembly.

Fig. 2 shows a rigid fixture, fastened to the floor, which is used to hold the center-panel section during the initial steps in its assembly. In the assembled plane, a wing is attached to each end of this section. As seen in the illustration, a plate is fastened to the assembly at each end, and two main locating pins lock the end plates to the fixture. In this fixture, the ribs of the center panel are assembled to the front and rear spars and the lower skin is attached. Special adjustable locators are shown along the trailing edge of the wing. These line up the center-panel flap hinges, and also prevent the hinge holes from being pulled out of line during the assembly of other parts. This wing section is about 32 feet long, and has a chordal width of 16 1/2

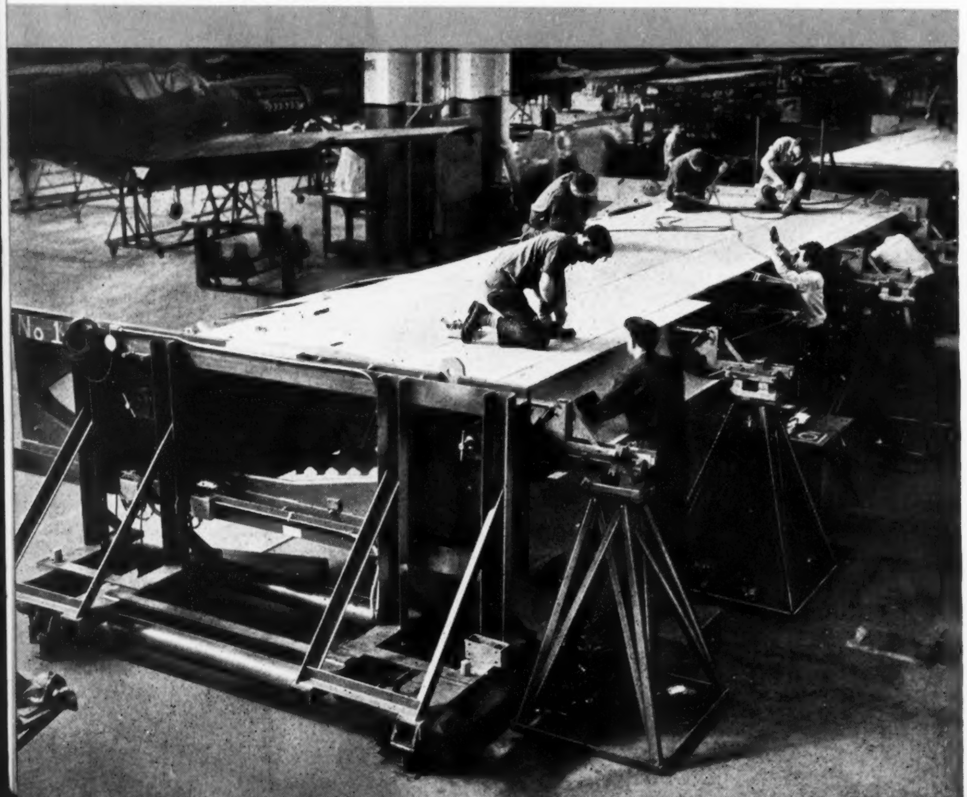


Fig. 2. Rigid Horizontal Fixture in which Initial Assembly of the Center Wing Panel is Carried on. Locators on Standards at the Right Hold Wing Flap Hinge Holes in Line

COMMANDOS

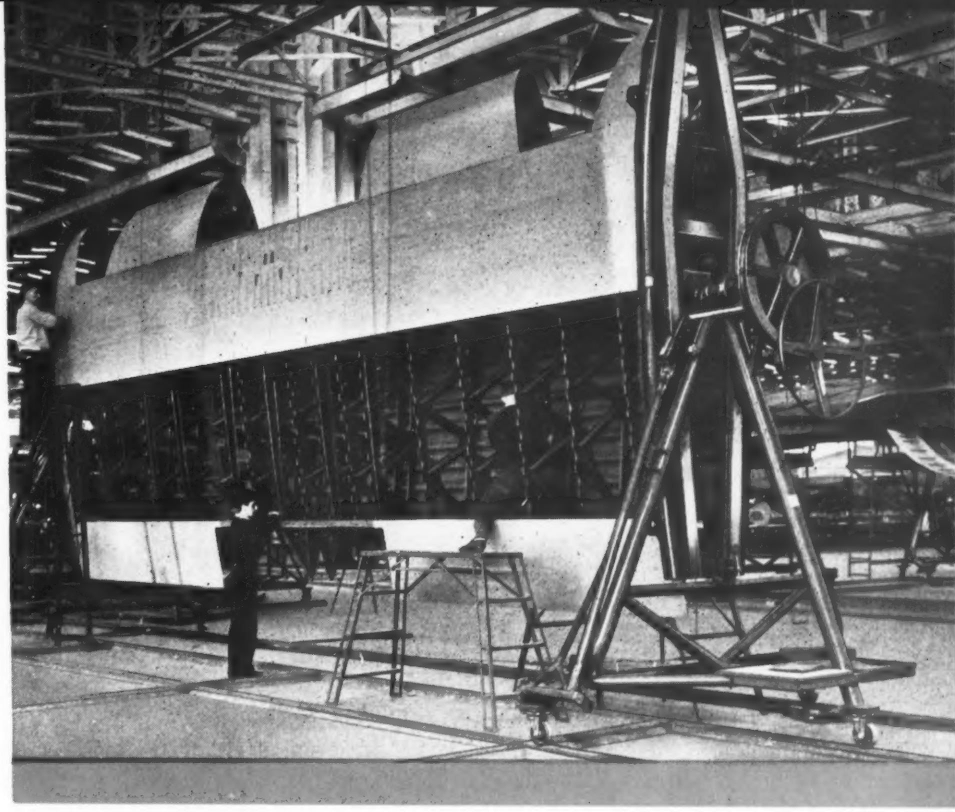


Fig. 3. (Right) Two Trunnion Dollies Support the Wing Panel after Its Initial Assembly. Tracks Guide Dollies to Successive Assembly Locations

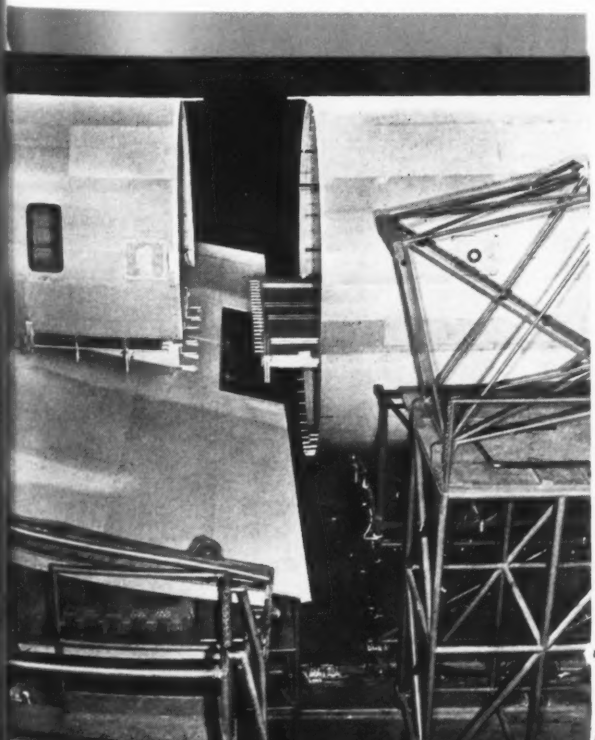
Fig. 4. (Below Left) Aft Fuselage and Center Wing-panel Sections being Pushed together preparatory to Splicing

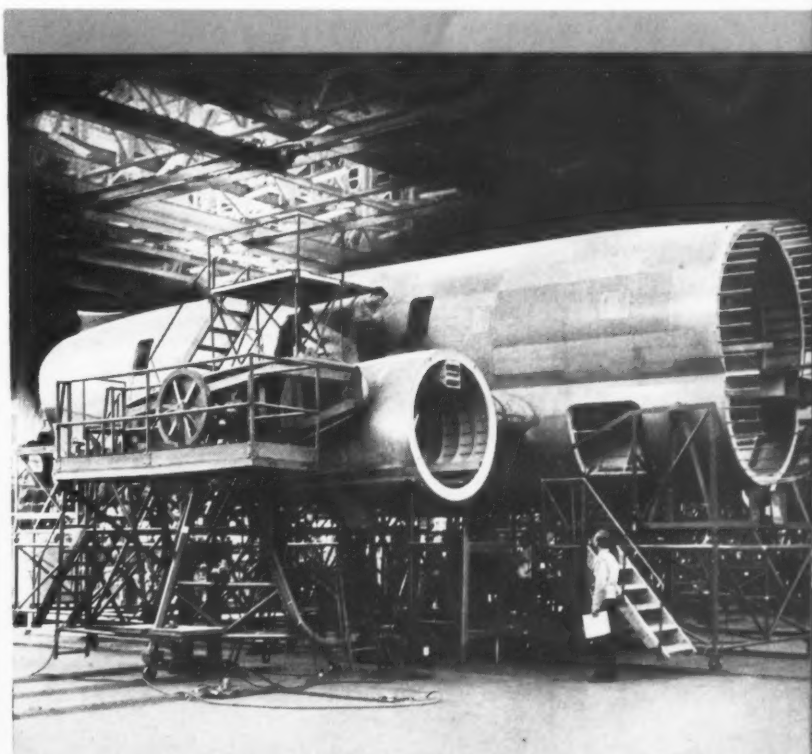
Fig. 5. (Below Right) Here Fore and Aft Fuselage and Center-panel Sections have been Spliced together and the Joints Covered with Skin. Nacelles have also been Attached

feet. The use of this fixture has made it possible to assemble the center-panel section three times faster than when vertical fixtures were employed. The accessibility of all points of the assembly is largely responsible for the time saved.

Following this stage of assembly, the partially completed wing panel is lifted out of the fixture and placed between two trunnion dollies, as shown in Fig. 3. These dollies are guided along a track to carry the center wing panel through each of the succeeding stages of assembly. The large handwheel shown on the dolly in the foreground turns a reduction gear, so that one man can rotate the entire wing panel to any desired position. In this fixture, the bottom skin is completed in a vertical position, and the top skin is attached. The more heavily braced construction seen at the middle of the panel is used because the cargo carrying floor of the fuselage passes over this area.

A jig lowered from an I-beam above the panel is used for drilling twelve holes required for fastening the fuselage to the center panel. Another fixture on rails holds a drill which can be moved up to either side of the center of the panel to drill holes for attaching the engine nacelles. These nacelles fit into the two open-





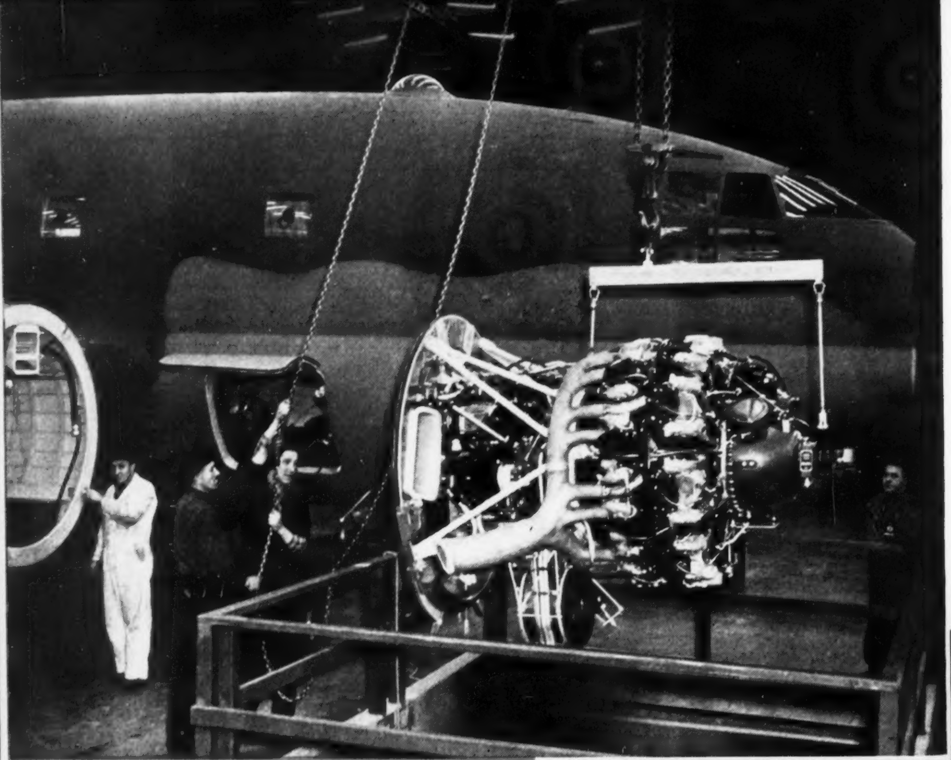


Fig. 6. Engines Move along Basement Accessory Assembly Line and are Lifted through the Floor at This Point, Ready for Fastening to the Nacelles

Fig. 7. Plane Nearing Completion before Taking to the Air for Flight Test. When Resting on the Tail-wheel, the Top of the Stabilizer Fin is Approximately 23 1/2 Feet from the Ground

ings in the leading edge of the wing panel at each side of the large center opening, as shown in Fig. 5. The fuselage itself fits into the center opening and is built around and extends forward and back from the center of the panel.

The aft-fuselage and center-panel sections are shown being pushed together preparatory to splicing in Fig. 4. In Fig. 5 is shown the manner in which the forward, aft, and center-panel fuselage sections are supported while being spliced together. The center-panel section, suspended between two trunnion dollies, is moved into place, and then the cradle dollies holding the fore and aft sections are brought into the splicing position. In splicing these sub-assemblies together, the stringers are joined and the entire joint is covered with skin. The main fuselage compartment for men, vehicles, or large cargo items, the girder supported floor, and the belly storage compartment underneath are clearly visible. The large opening in the lower section is the doorway to the belly compartment.

As the Commando plane moves down to final assembly, the Pratt & Whitney engines move along an accessory assembly line in the basement of the assembly plant. On arrival at the

bottom of the motor pit, they are complete and ready for attachment to the nacelles. Fig. 6 shows one of the engines being lifted out of the basement for attachment to the plane. The blister on the top of the fuselage is the celestial observation window used for navigation star and sun observations.

The three final assembly lines for the Commando plane describe a huge S curve, and as the ship arrives at the end of these lines, as shown in Fig. 7, it is ready for the final touches before it takes to the air. The large tail-wheel of the nearest plane is shown fully extended.

A comparison of this tail-wheel landing assembly with one used on a P-40 fighter plane, as shown in Fig. 9, is particularly impressive as an indication of the relative size of this plane. Some of the machining operations on the landing-gear assembly parts are of interest.

The milling of a slot in the steel landing-gear retracting arm is accomplished as shown in Fig. 8. Two 13 1/2-inch cutters are used in the center and two 13-inch cutters on the side. About 1/2 inch is taken off one side of the slot and 3/8 inch off the other. The cutters revolve at 13 R.P.M., with a feed of 1/4 inch per minute. The material is steel, heat-treated to a hardness of 38 to 41 Rockwell C and having a tensile strength of 180,000 to 200,000 pounds per square inch.

The work passes down through the first set of cutters as they rotate in a counter-clockwise direction. Then the table is moved transversely to bring the work into line successively with the

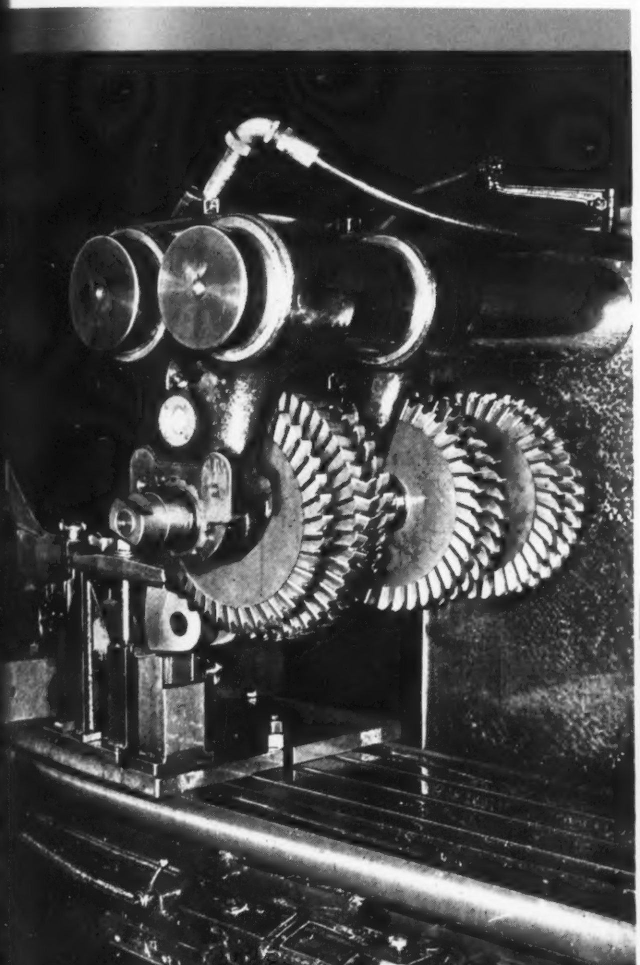


Fig. 8. (Left) Milling Slot in Steel Landing-gear Retracting Arm. Two Sets of Cutters at Right End of Spindle are Used Subsequently to Face Pads on Part of Work Projecting to Rear

Fig. 9. (Below) Comparison of Tail-wheel Assembly of Curtiss P-40 Fighter Plane (Center) and Two Tail-wheel Assemblies for Commando Planes

Fig. 10. Flame-cutting Three Slots in Landing-gear Part in 10 Minutes. Previous Method of Milling These Slots Took 198 Minutes

second and third sets of cutters, which face, to the proper widths, the pads shown on the arm projecting from the rear of the work-piece.

Another operation on a landing-gear part is shown in Fig. 10. The three slots in the end of this fitting were previously end-milled. The time required was 198 minutes per piece. The present method of flame-cutting the slots with an oxy-acetylene torch takes only ten minutes.

The use of a circular base with an American radial drill, as shown in Fig. 11, enables the operator to drill several different work-pieces in quick succession. Loading and unloading can also be carried on at one section of the table while work is being drilled at some other section. Another advantage of this arrangement is that heavy fixtures which hold work not immediately in demand may be allowed to remain on the table while other jobs are set up and run. The parts shown being drilled are for use in the landing gear.

A number of improvements have been incorporated in one of the Onsrud automatic contour milling machines used for milling wing spars. The first alteration was made so that the machine could mill a spiral and a 29-inch radius on the back of the wing spar with various angles at different stations, and at the same time scribe

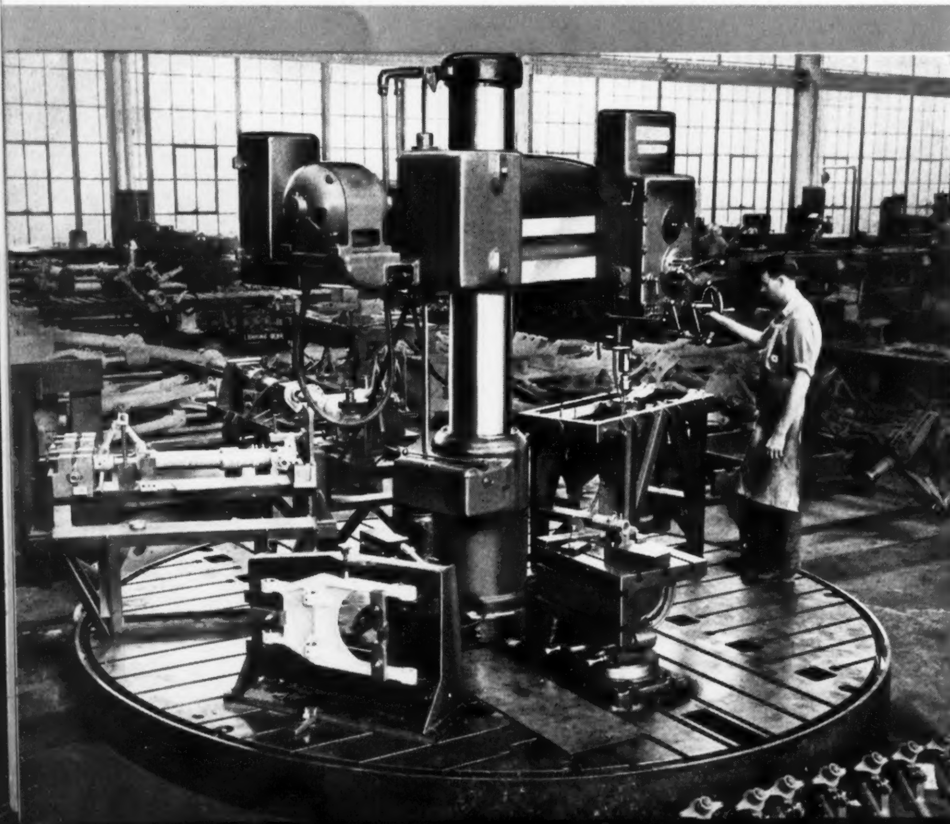
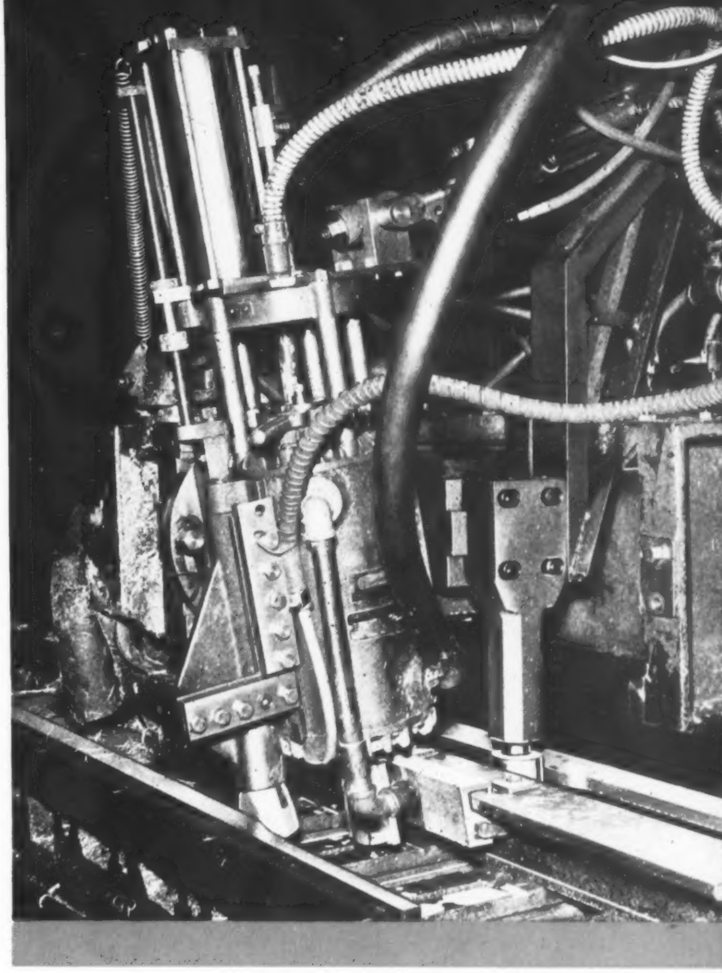


Fig. 11. Use of Circular Platform with a Radial Drill Enables Several Work-pieces to be Drilled in Quick Succession while Loading and Unloading Other Work Simultaneously



lines for cutting. A 9-inch radius cam mounted on the angle-iron already in use on the milling machine, and a cam cut to the angle to which the work-piece was to be milled, were both tried and proved unsatisfactory. Finally, a square cam, much heavier than the original, was mounted on a 5/8- by 4-inch by 20-foot angle-iron, as shown in Fig. 12. This cam gave satisfactory performance, and the increased weight of the cam, together with the heavier angle-iron, provided greater rigidity.

The rear roller was at first mounted solid with the gib that supported the motor. It was found, however, that each time the angle of the motor was changed the rear cam on the milling machine had to be reset to suit the changing contour of the spar. This difficulty was solved by cutting the gib in half. A simple adjustment of the rear roller leg then secured the correct angle for the particular job being handled.

A second alteration was made to improve the coolant supply to the horizontal cutter and to provide a means of clearing away the chips. As shown in Fig. 13, an atomizing type of nozzle, constructed somewhat like an injector, was evolved in which the coolant was mixed with compressed air. To make this nozzle, a length of 1 1/2-inch steel tubing was tapered at the outlet end by cutting slots, squeezing the tube to a smaller diameter, and brazing it solid. A length of 3/4-inch steel tubing was then inserted into the 1 1/2-inch tubing, the void between them was closed, and the entire end brazed into a solid unit. The addition of a 5/8-inch tubing connection to the side of the 1 1/2-inch tube provided the coolant inlet. The compressed air was connected to the 3/4-inch tube, thus giving the coolant pumped onto the work added force, so that the cutter was flooded and the chips cleared away. It will also be noted from the illustration that there is a compressed air jet

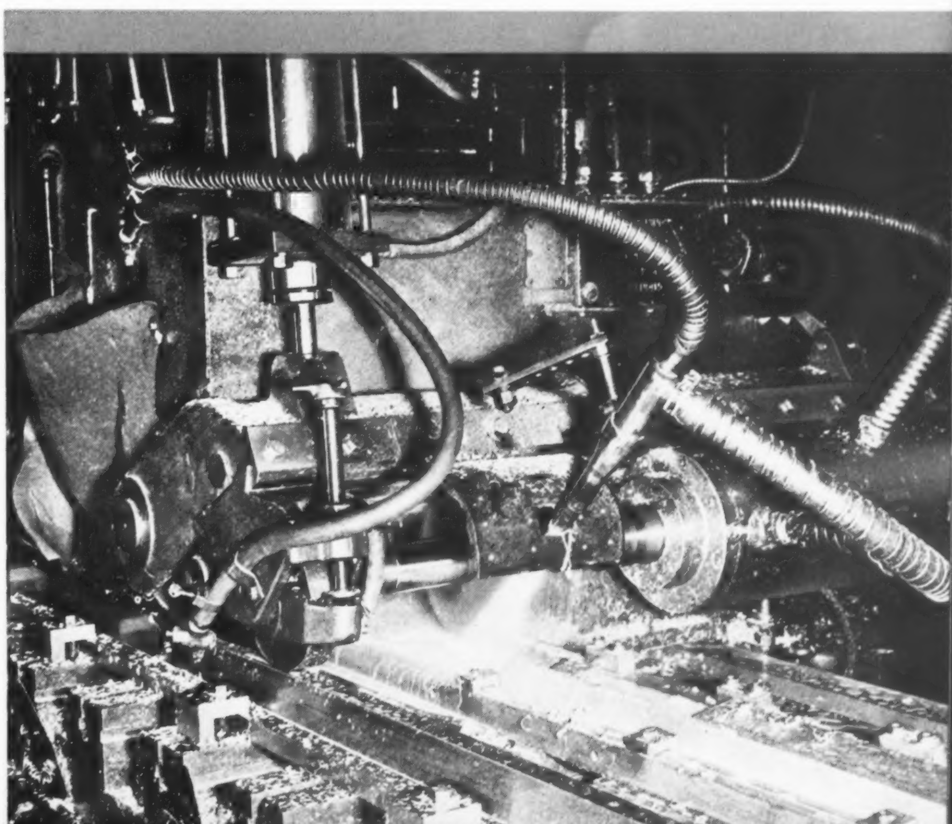
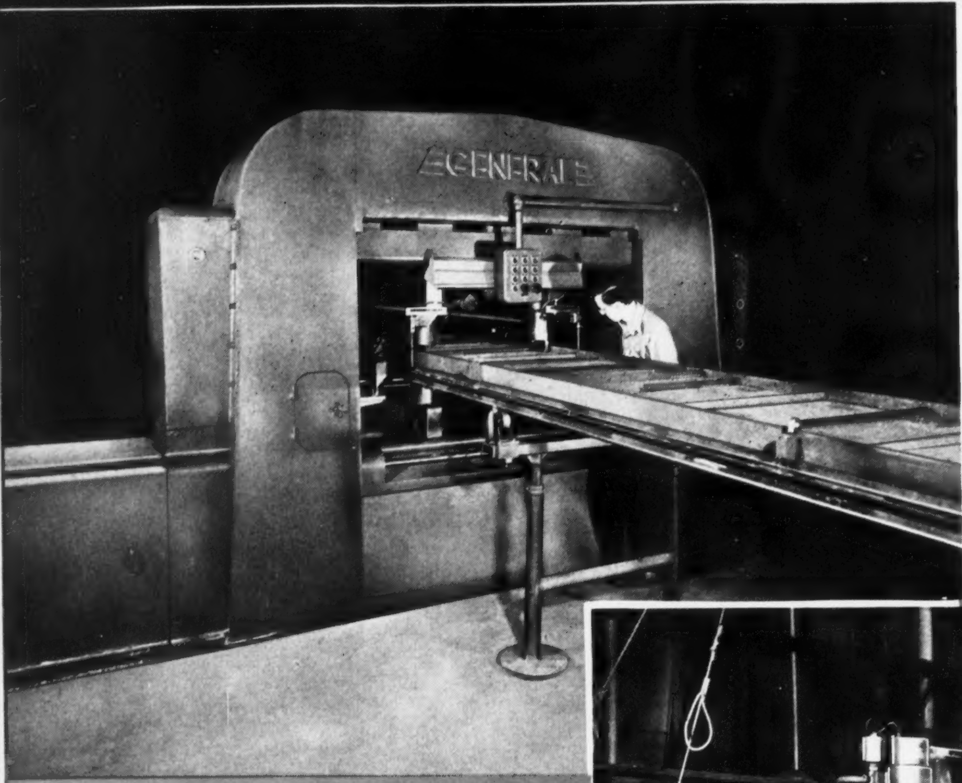


Fig. 12. (Above) Contour Milling Machine was Adapted for Milling Wing Spars by Using Square Cams Mounted on Heavy Angle-iron and by Cutting Gib that Supports Motor and Rear Roller in Half. Fig. 13. (Right) A Compressed-air Atomizing Jet Forces Coolant against Milling Cutter Rotating at 5100 R.P.M., and Air Jet at Side Clears Chips ahead of Carriage Wheels



CURTISS

Fig. 14. Automatic Multiple Riveting Machine Used to Handle Heavy and Extensive Riveting Work on the Commando Spars. Both Sets of Riveting and Bucking Heads are Automatically Positioned and Actuated

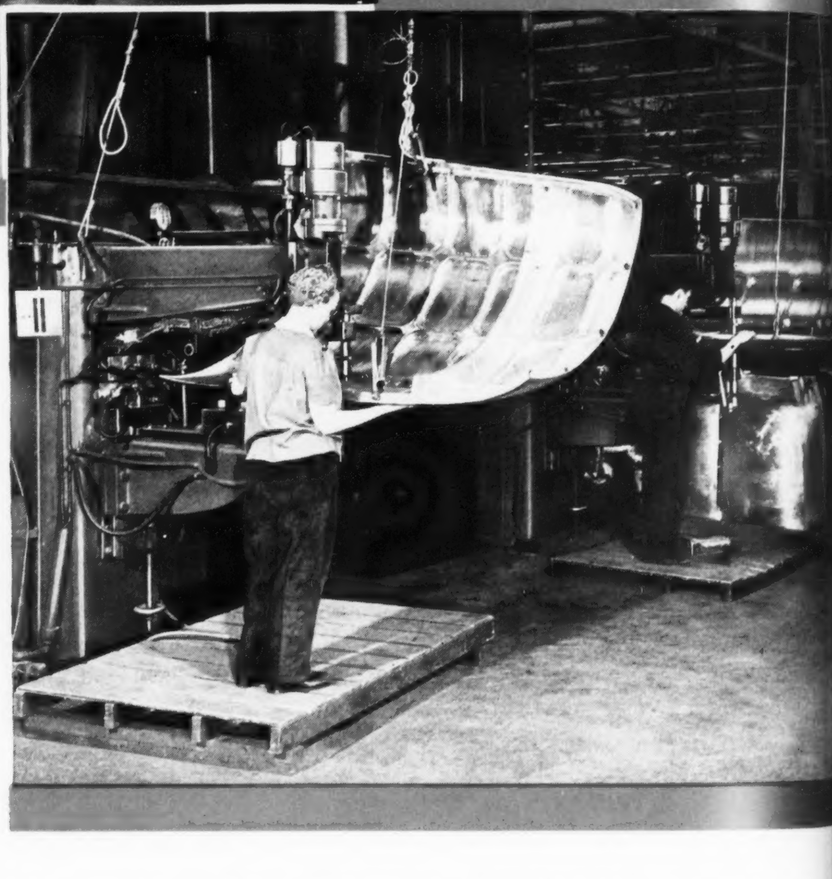


Fig. 15. Heavy Spot-welded Assemblies are Easily Handled by Women with the Aid of Suspension Holding Devices. The Spot-welding Machine Shown has a Throat Depth of 4 Feet

so located as to clear away any chips on the track as the milling carriage moves forward.

One of the most recent additions to the large production equipment in this shop is the new type of automatic multiple riveter illustrated in Fig. 14. This riveter was designed by the General Engineering Co. under the direction of Curtiss tool engineers to handle the heavy and extensive riveting work on the 30 and 70 per cent spars of the Commando plane. A time study shows that this machine has effected a saving of twenty-five man-hours per spar in riveting time. The operation of the riveter is automatic after the spar has been placed in the light receiving frame. This frame carries all the tracks and cams that automatically position and operate the riveting rams. Each stroke of one riveting unit will compress eight 3/16-inch rivets, or a total of sixteen 3/16-inch rivets for both heads.

Quite heavy work-pieces, such as the side cowl section of the engine nacelle shown in Fig. 15, are handled easily by one operator when spot-welding, with the aid of a clip type of suspension device. The particular spot-welding machine shown is a Sciaky model, and has a throat depth of about 4 feet, which permits relatively large sub-assemblies to be accommodated.

COMMANDOS FOR MILITARY AIR TRANSPORT

A rather difficult forming operation is illustrated in Fig. 16. The pieces shown are fairings for the celestial dome or transparent overhead observation blister. These fairings are completely formed and trimmed on the Chambersburg drop-hammer shown. Each piece is first formed under a rubber blanket, and is then taken to a heat-treating furnace. After heat-treating, it is restruck on the drop-hammer under the rubber blanket with the same die to correct any deformation introduced by heat-treating. The final operation is to strike the piece in the same die without the rubber blanket, so that the outside flash and the inner rim of the circular opening are sheared to the finished size. Both die and punch are made of Kirksite. The material is 0.040-inch 24-SO aluminum alloy.

Another difficult drop-hammer operation is illustrated in Fig. 17. Here, again, the part is formed and trimmed, and the sequence of operations is the same as for the celestial dome fairing. During the final trimming operation, the notches shown along the right-hand edge of the finished piece are also cut. This is a somewhat difficult operation because of the sharp draw.

Fig. 16. (Left) Forming and Trimming of Celestial Dome Fairing are Accomplished in Three Drop-hammer Operations. Finished Piece Shown at Left

Fig. 17. (Right) A Difficult Forming Operation Due to Sharp Draw Required. Drop-hammer Trims Piece and Cuts Notches, as Shown at Right

Production Short-Cuts

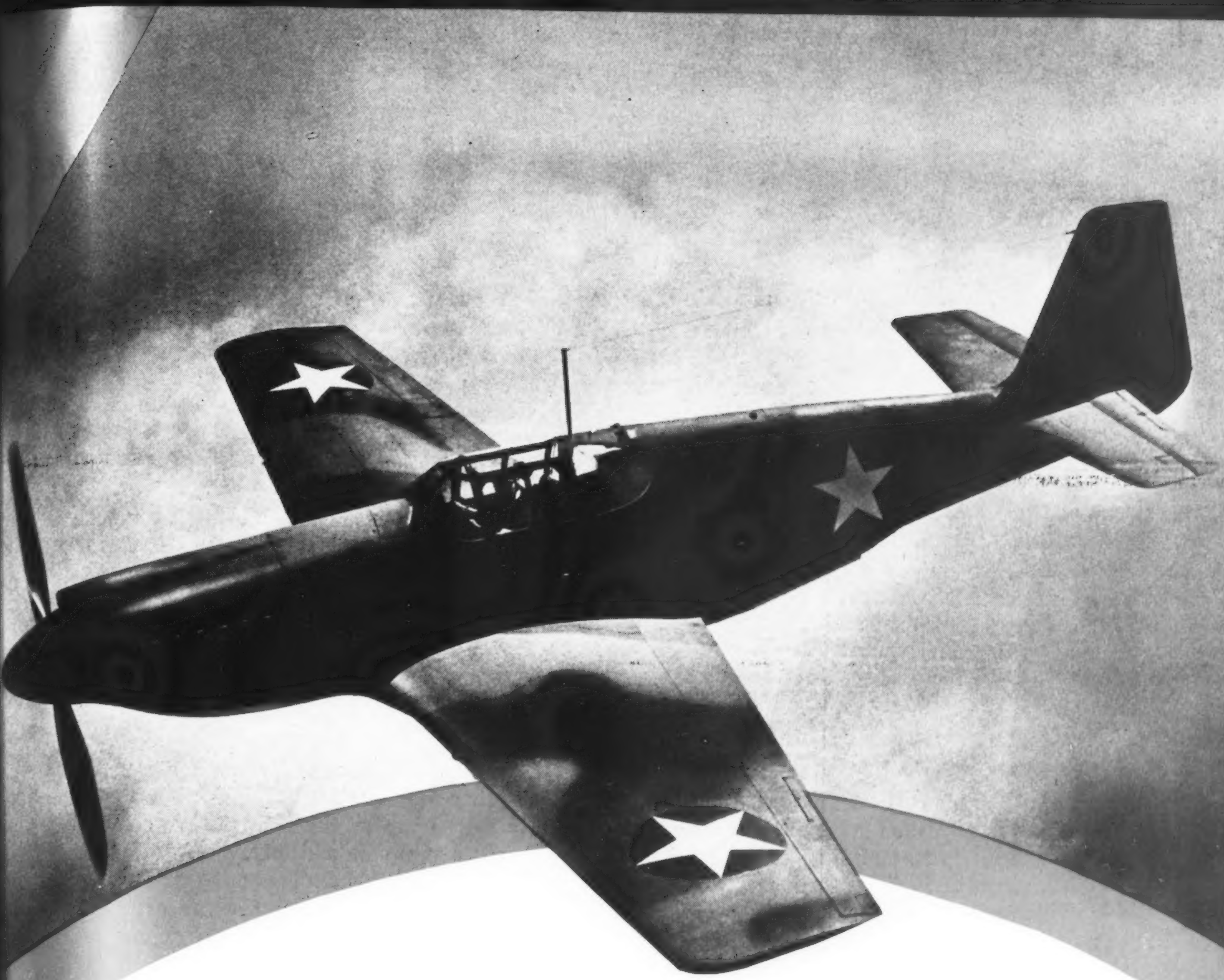
SPEED MUSTANGS AND MITCHELLS TO FIGHTING FRONTS

By RALPH H. RUUD, Assistant Factory Manager
North American Aviation, Inc.
Inglewood, Calif.

THE high output demanded today from aircraft plants to meet the urgent needs of fighting fronts the world around stimulates production men to employ their utmost ingenuity in devising time-saving manufacturing methods. Standard machines and methods have not yet been developed for producing all types of aircraft parts to the high quality required and in the minimum time. Frequently, therefore, occasions arise when production problems can best be solved through the application of special machines or tooling.

Many unusual methods have been worked out by tool engineers and production men in the North American plant at Inglewood, Calif., to turn out parts at unprecedented rates for two of America's most famous planes—the Mustang P-51 fighters, which were the first single-engine American planes to penetrate Germany, and the Mitchell B-25 medium bombers, which were used exclusively in the raid on Tokio and which have since appeared on every fighting front around the globe. Some of these methods have previously been described in MACHINERY; the more recent developments will be discussed in this article.

In forming many parts to shallow depths from aluminum alloy sheets on hydro-presses, it is practically impossible to avoid wrinkles along the edges that are forced down the sides of the Masonite forms by the rubber pads on



the press ram. The practice in the past has been to hammer out such wrinkles by hand, with the parts held on wooden blocks. This consumes much time and greatly increases the cost.

At the North American plant, the wrinkles are now smoothed out while the formed pieces are still on the hydro-press by placing wedges of Kirksite into grooves provided on the Masonite blocks in the manner shown in Fig. 1, after the pieces have been formed under the press ram in the conventional manner. These wedges are made to the same contour as the sides of the Masonite blocks, and have flat tops which are slightly higher than the work after the wedges have been placed in the Masonite forms. With the wedges in place, the work-table is returned under the press ram, and when pressure is applied, the wedges are forced to slide down the angular surfaces on which they are seated and are brought into firm contact with the flanges of the formed pieces. All wrinkles are effectively ironed out in this way, and the flanges are formed at a true right angle with the top surfaces of the parts, or to less than 90 degrees if desired. Dowels on the Masonite forms fit slots in the wedges to locate the wedges lengthwise.

These Kirksite wedges are about 3 inches wide and have a maximum thickness of 1 1/2 inches. Most of the forming work is performed on a Williams & White 3000-ton hydraulic press equipped with four tables, which are also actuated hydraulically. A pressure of about 1290 pounds per square inch is exerted in forming.

The use of dies made completely from Kirksite for both blanking and forming in one operation has proved very satisfactory for parts of comparatively shallow depth. Fig. 4 shows a typical operation in which three dish-shaped fairing pieces are simultaneously blanked and formed from a rectangular sheet of aluminum alloy. When the photograph was taken, an operator had lifted one of the pieces from the

Fig. 1. The Use of Kirksite Wedges in Hydropress Operations Eliminates Wrinkles around the Formed Duralumin and Steel Pieces

Kirksite block, but the two remaining pieces and the scrap were still in place.

Success in operations of this type depends upon stretching the material almost to the breaking point around the edges to be sheared. Thus, the die was made with a circular recess or trap about 1 1/4 inches wide by 1/4 inch deep around each cavity at a radius from the center of the cavity that would allow a flange of the required width around the part. When the press ram comes down, the rubber on the ram forces the metal first into these traps, then draws the metal to the bottom of the cavities, and finally shears off the scrap around the inner edge of each trap. The shearing edges are not especially sharp, being merely bored to a right angle with respect to the top of the die. They have been found to stand up indefinitely.

The Kirksite die shown is about 5 inches thick, and as the rubber pads on the press ram are only 7 inches thick, it was found desirable to stack pieces of rubber on the hydro-press table around the die-block, as shown, so as to insure application of the full ram pressure on the work blank and also guard against damage to the press.

Tremendous savings in time have been effected through the development of the stretching ma-

Fig. 2. Fixture Provided with Springs that Hold a Cam in Contact with a Roller on the Cutter-spindle for Performing a Contour Milling Operation

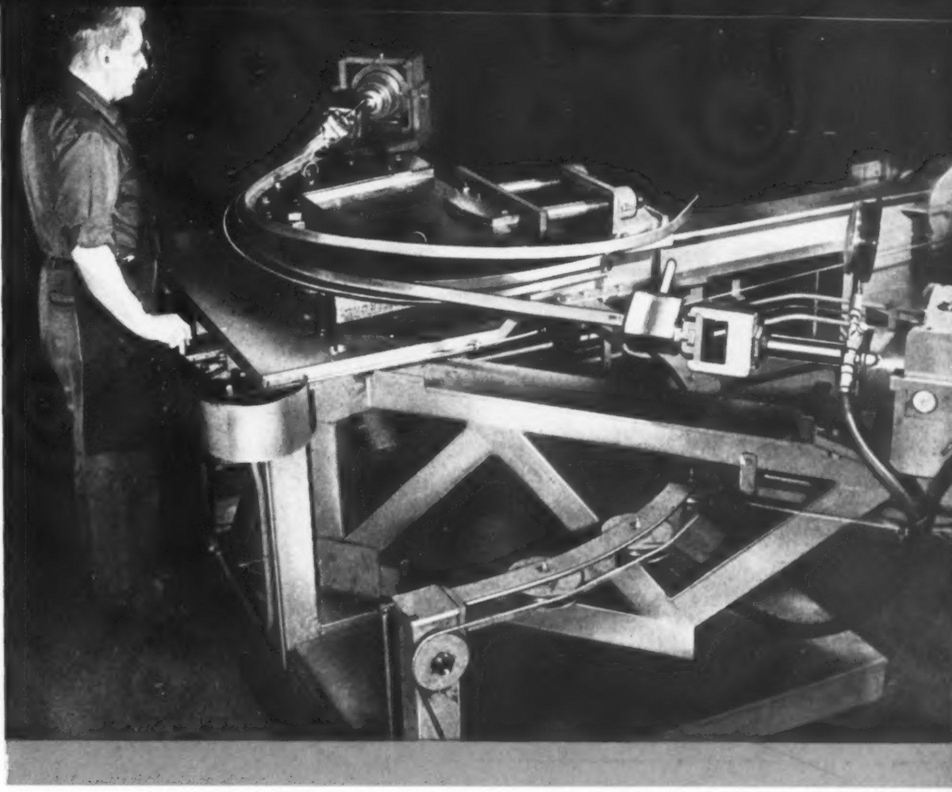


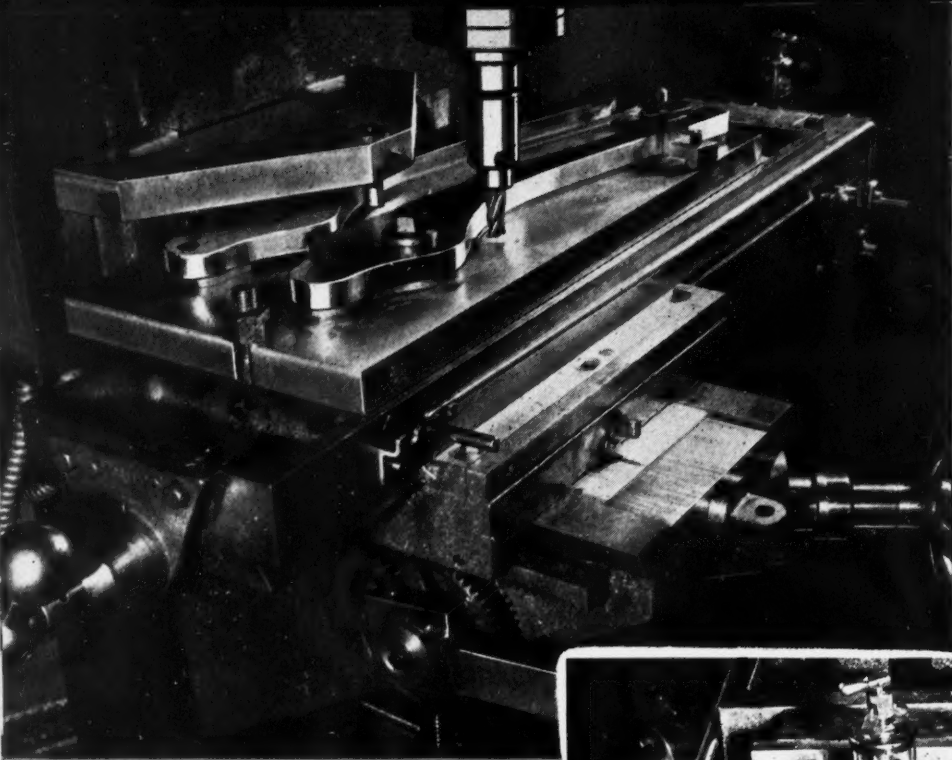
Fig. 3. Stretching Machine of Special Design which Saves Much Time in Forming Rolled and Extruded Shapes, Tubing, and Sheet-metal Strips

chine illustrated in Fig. 3, which is used in forming extruded and rolled shapes, tubing, and narrow widths of sheet metal. The machine is built with a stationary table on which a form is mounted having a contour corresponding with the shape to which the work is to be bent. A heavy block, mounted on an I-beam that extends to the rear, firmly supports the form during the stretching operation, there being two heavy adjustable screws on the block which bear against the back of the form.

On each side of the table there is a large structural swinging arm equipped with a hydraulic cylinder. The piston of each cylinder carries a head, as seen in the right foreground, in which there is a T-slot to receive a corresponding tongue on a clamp fastened to the end of the piece to be stretched. At the beginning of an operation, both arms are in a straight line extending across the front edge of the form. The piece to be stretched is fastened to each of the arms, and then pressure is admitted to the hydraulic cylinders for pulling the stock taut. Each cylinder exerts a tension of about 600 pounds on the stock.

Power is next applied by an electric motor, through a gear reduction unit and steel cables, to swing the two arms in unison toward the back

Fig. 4. Kirksite Die-block Used in Conjunction with Rubber Pads on a Hydro-press for Blanking and Drawing Dish-shaped Pieces in One Operation



NORTH AMERICAN

Fig. 5. Profile Milling Operation in which the Work is Accurately Guided along the Cutter by a Templet on the Back of the Table and a Stationary Guide Pin

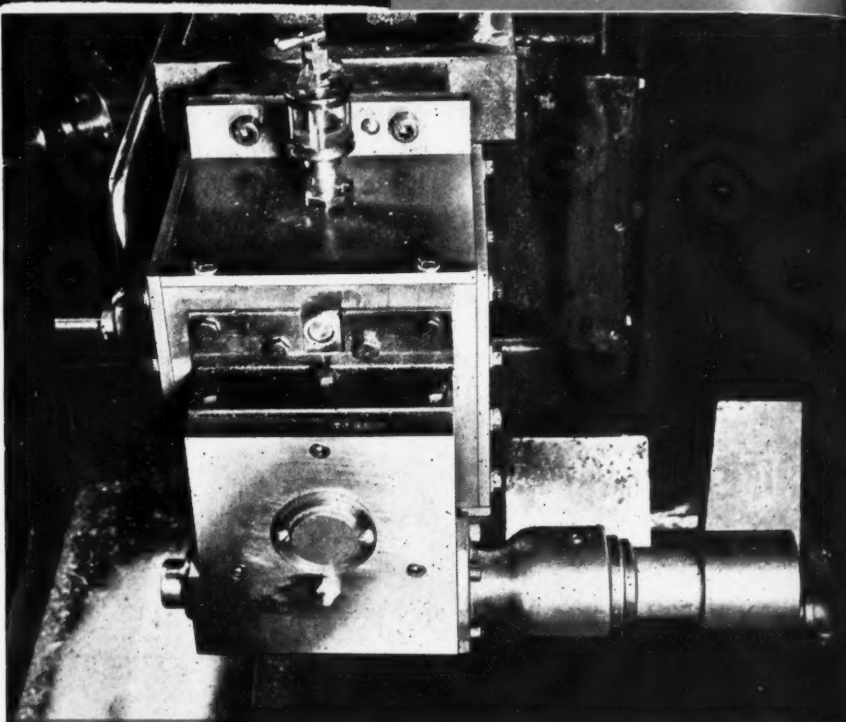


Fig. 6. An Air Motor Mounted at One End of the Table on the Machine Shown in Fig. 5 Drives the Lead-screw to Feed the Table

of the machine. Each of the arms can be swung through an arc of somewhat more than 90 degrees, as required for the individual operation. On extruded shapes, as in the case of the angle shape seen being formed in the illustration, the form is grooved to receive flanges on the stock. The practice is to stretch parts not more than one-half of 1 per cent along the inside, and thus wrinkles are avoided. In addition to an exceptionally high output, an outstanding advantage of this machine is the fact that new forms can be made in minimum time.

Many unusual tooling set-ups have been designed to facilitate the work of the machine shop. In Fig. 2, for example, is shown an ingenious fixture that enables two right- and left-hand landing-gear pivot castings to be milled simultaneously along a surface of constantly changing contour. The castings are of magnesium.

This fixture is constructed with a base on which there is a member that is permitted a certain amount of vertical movement. The work-pieces are clamped on opposite sides of this movable member. At the top of the central wall to which the work-pieces are clamped there is a cam that extends the full length of the fixture. This cam corresponds with the contour to be

milled on the magnesium castings. It bears against a ball-bearing roller, mounted on the cutter-arbor between two slab milling cutters. The cam is held in close contact with this roller through the action of four extension coil springs at each end of the fixture, which are placed between the base and the movable member.

In an operation, the movable fixture member, together with the work-pieces, rises and falls in accordance with the changing contour of the cam as the table is fed past the cutters. Both roughing and finishing cuts are taken. In roughing, stock to a depth of 3/16 inch and to a maximum width of 3 1/2 inches is removed from each casting at a feed of 25 inches a minute. The cutters are 3 1/2 inches in diameter, and are run at 445 R.P.M.

Another contour milling operation, which is being performed on a hand milling machine instead of on a far more expensive machine tool as in the past, is shown in Fig. 5. This operation consists of profiling dive brakes from 1/4-inch thick steel plates by employing a special end-mill, which is guided in the desired path around the work by the use of a pin on a bracket bolted to the machine column and a templet mounted on the table in back of the work.

In and out movements of the table are effected

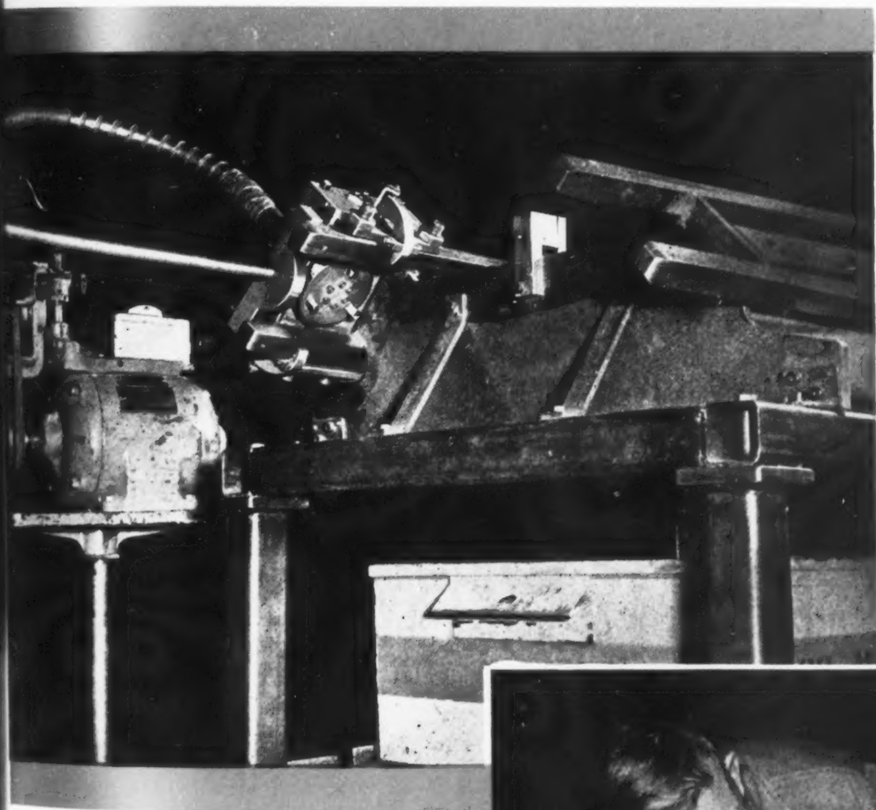


Fig. 7. Through the Use of a Special Cutter-head Driven from a Flexible-shaft Machine and a Suitable Fixture, Flanges are Machined to the Required Contour on Carburetor Air Scoops

Fig. 8. Another View of the Fixture and Cutter-head Illustrated in Fig. 7, Showing Method of Advancing Cutter-head along Fixture

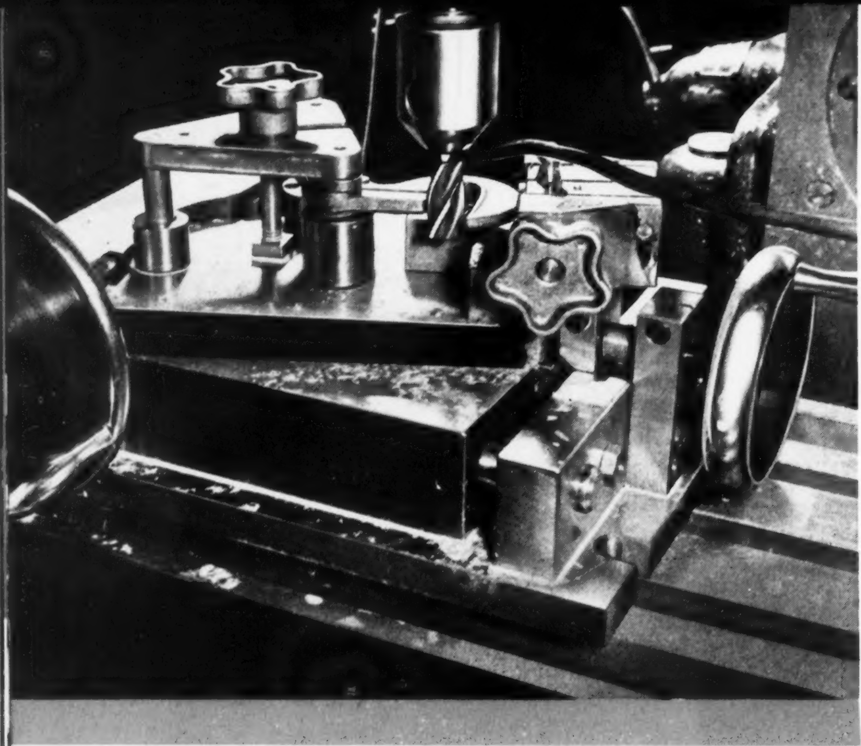


Fig. 9. Another Milling Operation in which the Required Profile is Produced by the Use of a Templet and Roller

by a long lever, which is swung up and down by the operator to revolve a pinion on the left-hand side of the knee, as seen in the illustration. The pinion engages a rack on the under side of the regular machine saddle. The table is fed longitudinally by an air motor, mounted on the right-hand end, as seen in Fig. 6, which drives the table lead-screw through worm-gearing.

Opposite sides of carburetor air scoops are made with two flanges designed to fit the contour of engine cowling. Formerly it was the practice to file these aluminum castings preparatory to assembling, and the filing time per casting was 45 minutes. Now, through the use of a special head with three fly cutters, arranged as seen in Fig. 7, and a fixture equipped with guide bars of similar contour to the flanges to be finished, these castings are prepared for assembly in a floor-to-floor time of only 12 minutes. The cutter-head is driven by a Strand flexible-shaft machine, and is fed along the work by a lead-screw which the operator turns by hand. The lead-screw is attached to the tool-head and extends through a nut mounted on the fixture.

Fig. 8 shows an operation actually in progress. It will be seen that the cutter-head slides along light bars which were bent to the required contour before assembly to the jig, so as to serve as cams. In addition to increased output, complete interchangeability of air scoops has been achieved by this finishing method.

Another profile milling operation greatly simplified by the development of a special fixture is illustrated in Fig. 9. In this case, a landing-gear hook, forged from chromium-molybdenum

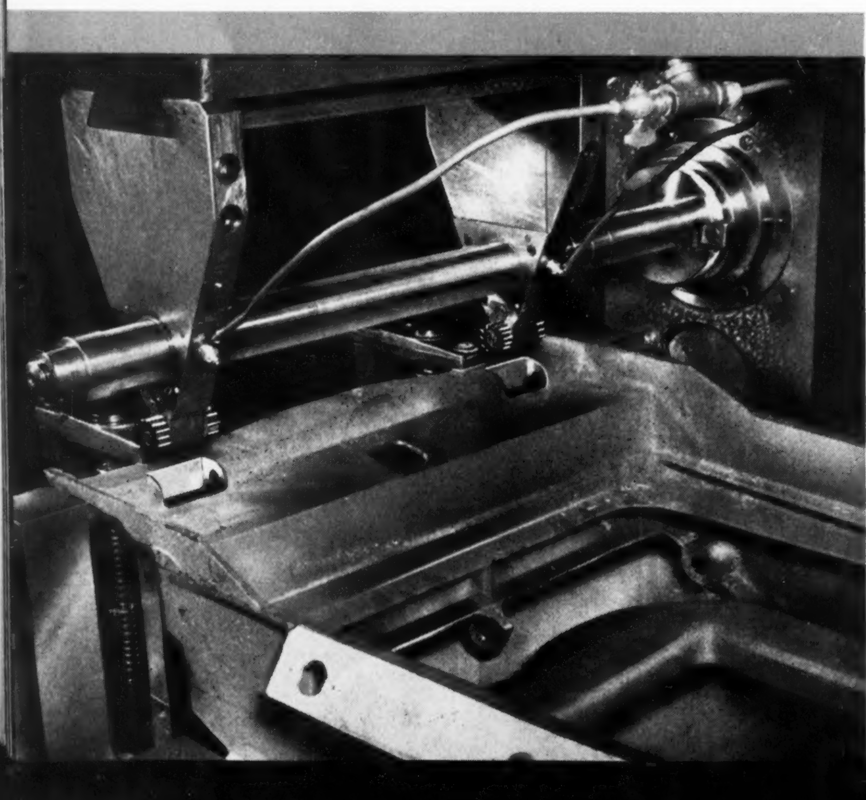


Fig. 10. Special Milling Set-up Devised for Simultaneously Finishing Four Surfaces that were Previously Back Spot-faced

SHOP METHODS

Fig. 11. Ingenious Tooling Set-up Devised for Turning Parts to Spherical Contour on a Turret Lathe

steel, is milled to a changing contour as the operator turns a handwheel on the fixture to feed a slide crosswise on the table. Spring tension holds a roller on the slide against the profile of a templet mounted on the left-hand end of the fixture, with the result that the work is held constantly in contact with the cutter. Previously, the practice was to set up the work on a milling machine and operate the various feed dials of the machine to feed the work past the cutter in accordance with a line scribed around the work.

A special arrangement devised for simultaneously face-milling both ends of two hinge openings in large aluminum castings is shown in Fig. 10. Four cutters, 1 1/4 inches in diameter by 1/2 inch wide, are used. These cutters are mounted on two special brackets, which are attached to the regular over-arm of the milling machine. The spindles on which each pair of cutters is keyed are driven from gears on a long arbor attached to the regular spindle of the machine, which extends through both bracket type cutter-heads. The drive from the arbor gears to the small cutter-spindles is effected through intermediate gears. The milling operation is performed by feeding the work upward to the milling cutters. Before this method was devised, the practice was to back spot-face all four surfaces, which was a slow and tedious process.

A tool made up for turning parts of spherical shape on a turret lathe is illustrated in Fig. 11. This device consists of a swinging arm, mounted on a stationary bracket which is keyed to a block on the cross-slide. The swinging arm carries a tungsten-carbide tipped tool which can be set at various radii with respect to the arm pivots for turning spheres of different diameters. The swinging arm is actuated by means of a link, which connects it to one of the faces of the hexagon turret, when the turret is fed forward or backward along the lathe bed.

In the particular operation shown, a spherical surface must be turned off center on the part, and the work-piece, therefore, is mounted on a special arbor, so that the surface being machined revolves on the axis of the headstock spindle. The specified spherical diameter is maintained within plus 0.001 inch, minus nothing.

Additional ingenious fixtures and methods employed in this plant will be described in a coming number of MACHINERY.

Vega's Experience with Carbide Milling Cutters

By R. G. OWEN
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Vega Aircraft Corporation, Burbank, Calif.

FACED with the challenge of increasing both production and the life of milling cutters, the Vega Aircraft Corporation began an experiment with carbide-tipped milling cutters in the summer of 1941, and through extensive research, redesign, and tests has solved the milling cutter problem. Prior to the time mentioned, large normalized wing fittings, forged from S A E 4140 steel, were milled on three sides with a 6-inch high-speed steel face mill that was run at a cutting speed of approximately 60 feet a minute with a table feed of from 3 to 4 inches a minute. The depth of cut was from 1/32 to 5/32 inch on the base and from 1/8 to 3/16 inch on the sides. With this method, each piece required about 2 3/4 minutes of cutting time, and it was necessary to regrind the cutters after every sixty to seventy fittings. The time consumed in grinding the cutters was 1 1/2 hours per cutter.

In order to speed up production in this operation, the writer developed a face mill type of carbide-tipped cutter having four replaceable tool bits made from lathe tools. This cutter was of somewhat novel design in that each bit or tip cut independently of the others. It could be classed as a combination face mill and fly cutting tool, since the bits were adjustable for height, as indicated in the drawing of this tool, Fig. 2.

After extensive experiments with this tool, it was determined that a cutting speed of 525 feet a minute, together with a table feed of 10 1/2 inches a minute, gave the best results. However, in view of the draft angle of the forgings and the amount of material to be removed from the sides, it was decided that only the base of the fittings should be milled with the new cutter. Only 50 seconds was required to machine the fitting bases, and it was found that one set of carbide inserts lasted for from 100 to 125 parts before regrinding was necessary. This showed that the use of carbide-tipped cutters not only reduces production time tremendously, but also results in increased life of the cutters.

Encouraged by this first success, more extensive experiments were embarked on. In June, 1942, designs were started for making cutter bodies from aluminum bronze, manganese bronze, cast steel, cast iron, steel plate, and steel bars. This large variety of materials was selected with the realization that the factors of prime interest—namely, the cost of material, shock resistance, machinability, and brazing characteristics—would influence the final selection of the materials to be adopted for cutter bodies. By a process of experimentation and elimination, the

Fig. 1. Assorted Hyper- and High-cycle Milling Cutters in a Tool-crib Cabinet

following materials were selected as suitable: (1) Cast iron having a tensile strength of approximately 50,000 pounds per square inch; (2) normalized cast steel having a tensile strength of from 60,000 to 90,000 pounds per square inch; and (3) S A E 1020 to 1050 bar stock or plate steel.

Although manganese bronze proved very satisfactory for cutter bodies, this material was eliminated because of the high cost. Aluminum bronze proved unsatisfactory because of the difficulty of brazing with either silver solder or bronze. Other materials were rejected for reasons of impracticability.

The first carbide-tipped cutters for machining steel in production quantities were of the face mill type. In determining the number of cutter tips to provide on a tool, various ratios were tried out. Some cutters were designed with one tip per 2 inches of cutter body diameter, some with one tip per inch of cutter body diameter, and others with one tip per inch of cutter body diameter plus two tips; in the latter case, for example, a cutter body of 6 inch diameter would be provided with eight tips. While the last formula proved to be the most suitable, it was found that, in some cases, the tip ratio had to be higher. This depended upon the material, the type of cut to be taken, and last, but not least, on the type of equipment and its condition.

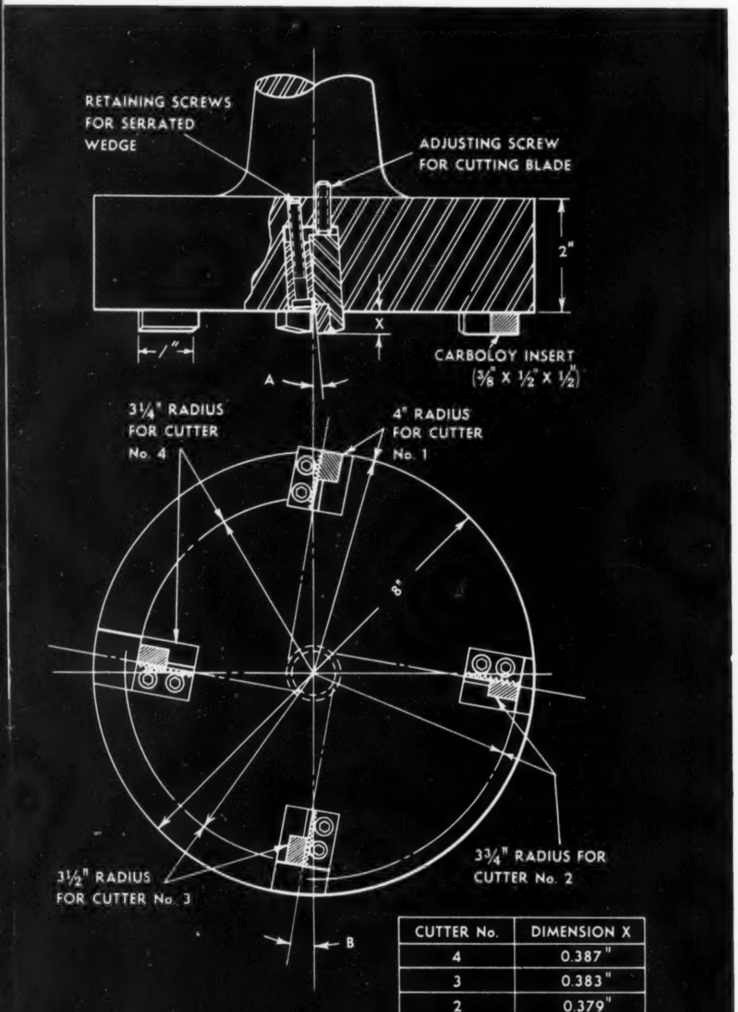
Hyper-milling—that is, the milling of steels with carbide-tipped cutters designed as explained in the following—has proved very successful in machining normalized or annealed steels, nickel alloy steels, S A E 4130 and 4140 steels, and similar materials. Cutting speeds of from 375 to 1000 feet a minute can be used, the speed also being dependent upon the individual job and the equipment. Hard-and-fast rules for cutter speeds covering all types of cutters should be avoided.

Proper cutting speeds and feeds go hand in hand, and vary inversely. At the relatively low cutting speeds of from 375 to 400 feet a minute, the feed per tooth should be approximately 0.005 to 0.007 inch. As the speed increases, the feed must drop proportionately to a minimum of from

VEGA'S EXPERIENCE WITH

0.0005 to 0.001 inch per tip at 1000 R.P.M. At no time should the feed of a carbide-tipped tool be as low as 0.0005 inch per tooth. The carbide tip should be actually cutting at all times.

It has been Vega experience that a carbide-tipped milling cutter can be dulled in from three to five minutes if the feed is lighter than 0.0005 inch, because with such a feed, a burnishing action is set up and heat is generated on the edge and bottom side of the tip where there is little or no shearing action, with the result that the metal being milled is caused to compress instead of flowing ahead of the cutter tip. For best results, the depth of cut should be held to less than 3/16 inch when using a carbide grade that offers resistance to both shock and abrasive action. Heavier cuts may be taken by using tougher grades of carbide or those that have very high shock resistance.



CUTTER No.	DIMENSION X
4	0.387"
3	0.383"
2	0.379"
1	0.375"

There is a distinct advantage in providing a negative rake angle on the carbide tips of milling cutters, as indicated at *A*, Fig. 2, and in inclining the cutter blades at an angle *B* from true radial positions. Locating the blades at an angle with the radial position, and with the inner edge leading the outer edge, has been proved by extensive tests and production runs to be most effective in giving a better machine finish and increasing the number of parts obtainable per grind. A negative rake angle has less effect upon production and cutter performance. It should be remembered also that, to make a cutter with a negative rake and also set the blades to an angle *B*, would necessitate much greater horsepower for driving the cutter than would be the case with a cutter having the blades set at angle *B* but with a positive or neutral rake.

To give absolute rake angles and blade angles would be impractical, in view of the fact that application of carbide-tipped milling cutters is still in the experimental state. Consequently, any rules based on formulas are as yet without sufficient proof and are of academic value only.

Cutting speeds may vary from 75 to 400 feet a minute, depending upon the hardness of the material. For example, steel of 600 Brinell hardness can be milled at 75 feet a minute, but if the hardness is decreased, a faster speed can be employed. A large face mill of the true Vega hyper-milling type is shown in the middle foreground of Fig. 3. This cutter is 12 inches in diameter by 3 inches thick, and weighs over 60 pounds. The thick backing provided for the cutter tips should be particularly observed. Cutters of this type must have sufficient weight to produce the momentum necessary to withstand shock and eliminate backlash and thrust motion.

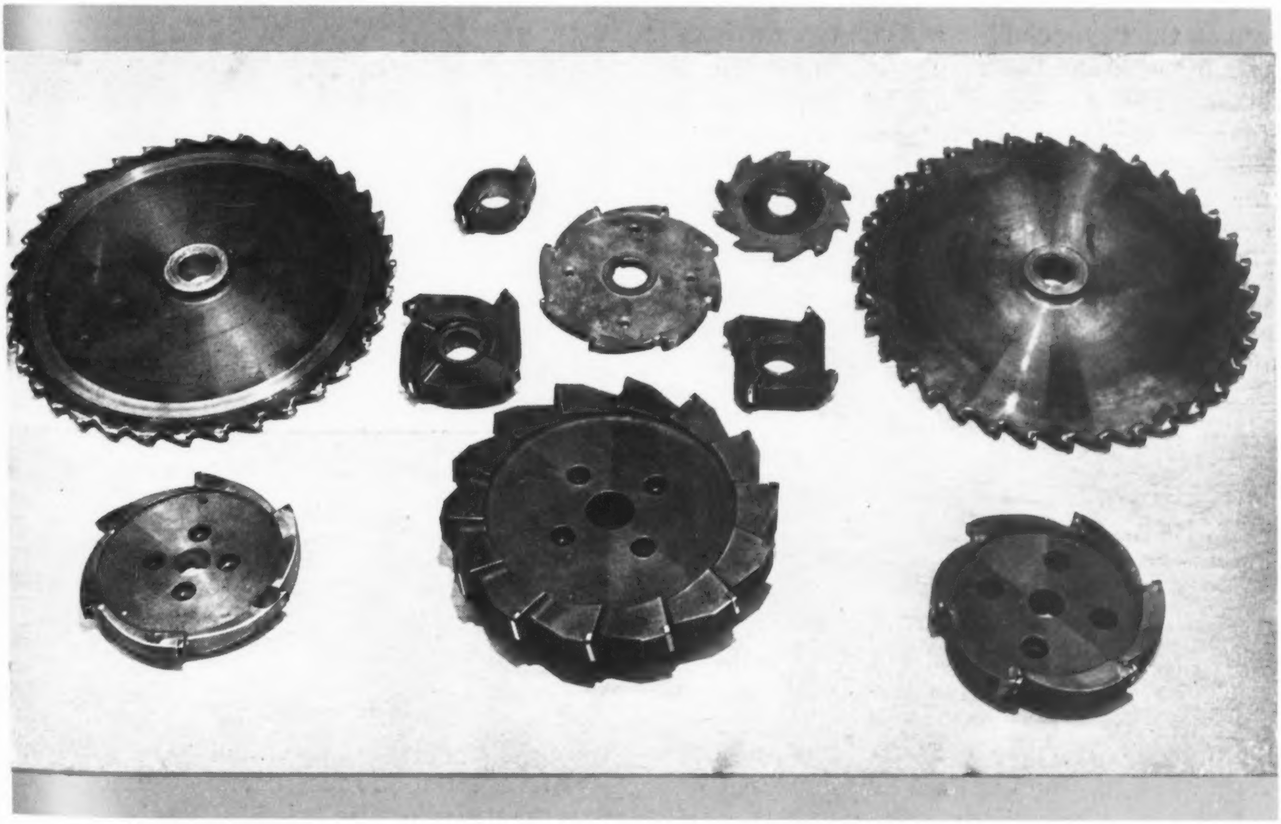
Fig. 2. Construction Drawing of a Typical Carbide-tipped Face Mill for Machining Steel, which Shows the Negative Rake Angle A and the Angle B Offset of the Carbide Tips from Radial Lines

Lighter face mills have been used on the same jobs as the heavier type of cutters, and it was found that the life per grind is in favor of the heavier cutter in the ratio of 2 to 1. Tests were also conducted in which lighter cutters were used in combination with flywheels to make their weight equal to that of the larger cutters. The results indicated that the lighter cutters lasted 50 per cent longer when they were used with flywheels than without them. These experiments have shown convincingly that hyper-milling cutters, of the face mill type especially, must have ample backing for the cutter tips and be as heavy as it is reasonably safe to handle.

Approximately 135 face mills of various sizes are in use at the Vega shop at present, and an additional 50 cutters ranging from 4 inches in diameter upward are being made in the Vega shop and by outside venders. Some of the cutters in constant use are shown in Fig. 3. All but two are made with bodies of boiler plate. The large slitting saws at the rear, left and right, are 16 1/2 inches in diameter, and were designed for slitting a special wing fitting of S A E 4140 chromium-molybdenum steel. The finished slit width must be within 0.339 and 0.349 inch. The slit is 3 inches deep and approximately 7 inches long. This slitting operation is illustrated in Fig. 4.

A special attachment locked to the over-arm of the milling machine is provided with two dogs that maintain a positive contact against the sides of the cutter directly above the work and as near as possible to the outer edge of the cutter. This attachment acts as a vibration dampener, and is largely responsible for the exceptional performance of this cutter. Before this method was developed, the slitting of this part was a slow and costly process, taking 94 minutes for roughing and finishing, whereas the slot is now milled in a total time of only 3 minutes. Thus, a saving of 91 minutes per piece is realized, and, besides, a

Fig. 3. Assortment of Cutters Used in the Vega Shop in Hyper-milling Operations on Steel Parts



CARBIDE-TIPPED

Fig. 5. (Below) Various Carbide-tipped Cutters Used on High-cycle Milling Machines Operated at Spindle Speeds of 3500 to 15,000 R.P.M.

Fig. 4. (Above) Operation in which a Carbide-tipped Saw Cuts a Long Slit in S A E 4140 Fittings in Record Time

much better finish is obtained. Work rejections have been greatly reduced.

Four grades of carbides are recommended for use on the hyper-milling cutters, two grades for cutting steel and two for cutting duralumin and other materials. Experience has shown that the four grades are sufficient for machining 90 per cent of the work. The proper selection of grades for different materials requires considerable experimentation.

Much of the credit for the development of the carbide-tipped hyper-milling cutters goes to a small group of Vega men who were convinced that more efficient milling methods could be devised than were in practice in 1941. These men, Harry Katt, Ray Katland, and Richard Daugherty, tool designers; Gene Strawn, machine shop foreman; George Humphries, machine shop tool man; J. Haldeman, manager of the tool engineering department; Bert Loyd, superintendent of manufacturing engineering; and the writer, were imbued with an idea and the conviction that it could be carried out. Through their contribution, important savings in time, materials, and cost have been achieved. Messrs. Katt, Owen, Strawn, and Humphries are seen in that order from left to right in the heading illustration.

Carbide-tipped milling cutters for the high-cycle milling of aluminum alloys are also used extensively in the Vega shop. There are five high-cycle milling machines in service built with spindles that are adaptable to horizontal or vertical applications. The spindle speeds range from 3500 to 15,000 R.P.M., so that cutters can be operated at speeds of from 5000 to 25,000 feet per minute. Over 90 per cent of the cutters used on these machines are carbide-tipped.

MILLING CUTTERS

Fig. 6. (Below) Tool-crib Attendant Holding Two Carbide-tipped Milling Cutters of the End-mill Type Used on High-cycle Milling Machines

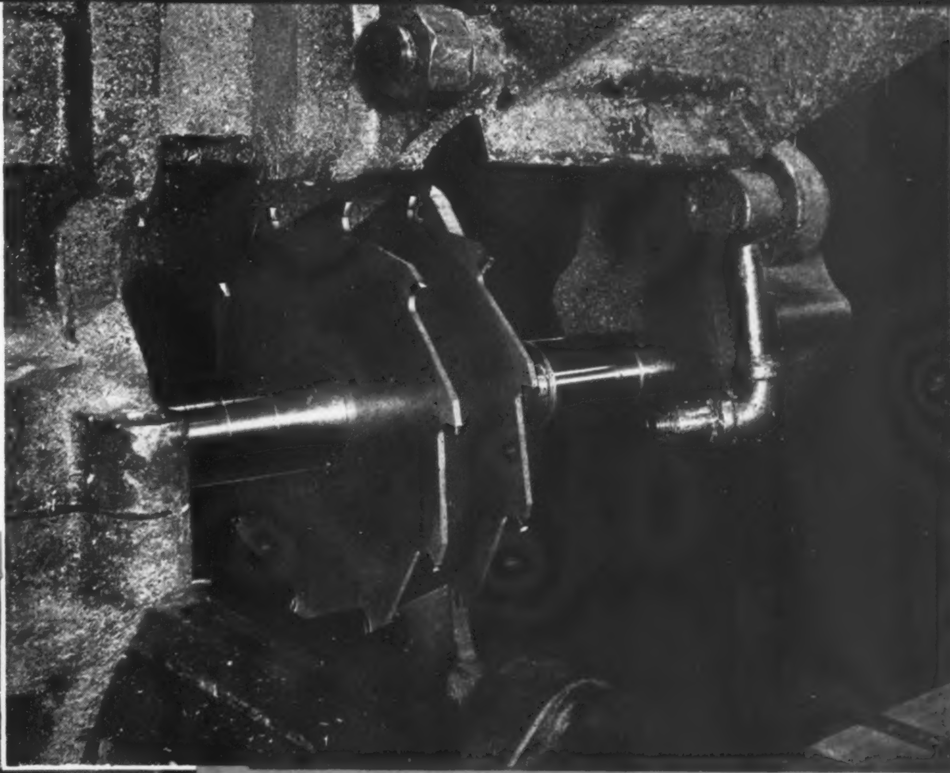


Fig. 7. (Above) Two 10-inch Carbide-tipped Slitting Saws Run at 23,000 Feet per Minute in Cutting Aluminum

An assortment of these cutters is shown in Fig. 5, while Fig. 6 shows a crib attendant holding two end-mills designed especially for use on the high-cycle milling machines. The rake angle on these cutters is positive, and amounts to between 7 and 15 degrees, while the cutting edges are inclined from the radial position at similar angles, with the outer edge of the blades ahead of the inner edge; this is directly the opposite of the position of the blades on hyper-milling cutters. Two- and three-tipped cutters, such as seen on the upper shelf in Fig. 1, are also used on high-cycle milling machines.

By the use of carbide-tipped cutters, production of aluminum parts has been increased on many jobs as much as 500 to 1000 per cent. In straddle- and face-milling operations, table feeds up to 150 inches per minute are used, and in some cases, where light facing cuts are taken, the table is traversed at 300 inches a minute. Best results are obtainable with a feed of 0.001 inch or more per cutter tooth on the high-cycle milling machines, if a solution of soluble oil and water, finely atomized by air, is directed at the point of tip contact with the work.

Two carbide-tipped slitting saws are seen being used in Fig. 7 for cutting segments from a bar of 24 ST aluminum. The cutting speed of these saws is approximately 23,000 feet per minute, and the feed per tooth is from 0.0015 to 0.002 inch. The body of these saws is made of boiler plate. The width across the carbide tips is 1/4 inch. A large number of these saws in diameters of 4, 6, 8, and 10 inches are in constant use.

Owing to the speed that can be used with these carbide-tipped slitting saws, it was found neces-

sary to provide adjustable air vises for holding the work-pieces, since with ordinary hand-screw clamping arrangements, it required 500 per cent more time for loading and unloading the fixtures than for the actual cutting.

Another operation on a high-cycle milling machine is illustrated in Fig. 8. This consists of straddle-milling the periphery of aluminum fittings to produce a hexagonal head. The cutters run at a speed of 12,000 feet a minute, and the table is fed at a rate of 120 inches a minute. The work is indexed three times, and fed past the cutters a similar number of times to produce a complete hexagon.

The carbide-tipped cutters for milling duralumin differ somewhat from the cutters designed for the hyper-milling of steel, inasmuch as they are made with fewer tips, are lighter in construction, have a positive rake angle, and are made with the outer edges of the blades leading the inner edges. They conform closely to conventional high-speed steel staggered-tooth cutters so far as rake and the radial location of the carbide tips are concerned. The number of cutter tips provided is in the ratio of one tip or less per inch of cutter body diameter.

Cutting speeds of over 1000 feet per minute can be used on ST aluminum sheets and on castings, and the speed can be increased proportionately as the hardness of the work drops. It is possible to use a greater feed per tooth than with the cutters intended for steel; satisfactory results can be obtained with a feed from 0.001 to 0.020 inch per tooth per cutter revolution.

Carbide-tipped cutters afford many advantages in machining non-ferrous materials, of which the most important are: (1) An increase in production of from 500 to 600 per cent, and an increase in the number of parts machinable per grind of from 300 to 400 per cent; (2) the availability of carbide tips, whereas high-speed steel cutters are at present on the critical shortage list; (3) a finish far superior to any obtainable by using high-speed steel cutters.

The best method of brazing carbide tips to cutter bodies is the electric induction method, since by this method the heat can be controlled and confined to the immediate locality of the tips. This method is also fast, and warpage of the cutter is held to a minimum. However, the cost of the machine for this type of brazing is exorbitant for concerns not engaged in cutter manufacture, and Vega engineers have found torch brazing entirely satisfactory. Bronze rod or other accepted brazing alloys are commonly used. The strength of the brazed joint is equal to or greater than the tensile strength of the brazing material. Proper temperatures to be used for the various brazing materials can be obtained from manufacturers' catalogues.

There is a marked drop in the strength of a brazed joint as the thickness of the brazing alloy increases. The greatest strength is obtainable when the thickness of the brazing alloy in the finished joint is between 0.001 and 0.003 inch. Sheet brazing material from 0.003 to 0.005 inch thick will give such a joint. There is a definite advantage in brazing at low temperatures, since there will be less expansion of the metals and, consequently, a smaller stress set up between the cutter body and the carbide tips.

In preparing joints for brazing, the following

Fig. 8. Milling a Hexagon Head on Aluminum Fittings with a Table Feed of 120 Inches a Minute, and a Cutter Speed of 12,000 Feet a Minute

procedure is recommended: (1) Try the tip in its recess to ascertain that it fits closely. (2) Touch the faces of the tip to be brazed against either a soft grit or diamond grinding wheel, in order to remove any scale or dirt that may adhere to the tip. (3) Immerse the body and the tip into a commercial solution of hydrochloric acid and then into carbon tetrachloride to further cleanse the parts. Then thoroughly scrub the parts with a paint brush soaked in carbon tetrachloride. (4) Flux both the recess in the body and the tip thoroughly. Cut the sheet brazing material to size and place it in the recess both under and around the sides of the tip. Flux all over again. (5) Apply heat to the bottom of the body. Direct the blaze outward, taking particular care to see that the tip does not become overheated. A uniform heat underneath the tip is necessary to obtain the best results, although it is important to keep the torch moving to prevent local overheating. This procedure should be kept up until the brazing alloy melts. During the heating time, the tip must be held firmly in place in order to force out all excessive brazing alloy and to hold the tip firmly in the recess. (6) Flux again. (7) Cool slowly by immersing in either powdered charcoal, lime, asbestos, mica, or graphite. Do not quench. Quenching will invariably result in a cracked tip.

Both the angles of the tips and their surface finish are very important to satisfactory tool performance. In order to determine the desired finish for the various carbide tips, it is advisable to take a number of photomicrographs, so that the results obtained by using grinding wheels of various grits can be studied. In tests conducted in the Vega tool-room, a carbide tip ground with a 60-grit vitrified wheel had a very rough edge, which would be unsatisfactory except for use in taking a roughing cut. Another carbide tip ground with a 100-grit diamond wheel had an acceptable finish for short runs. Two carbide tips ground with a 180-grit diamond wheel had slightly smoother surfaces and edges, while a tip ground with a 320-grit diamond wheel had the smoothest surface and edge. All samples were ground with a feed not exceeding 0.0005 inch per pass, and the motion of the grinding wheel was perpendicular to the cutting edge.

Cutters tipped with carbide are easily chipped and spoiled in handling. It is, therefore, important that individual cutters should be kept in containers made of wood or some similar material while they are stored in the tool-crib and during the time that they are in transport to and from the machine shop or the grinding department. Fig. 9 shows how the hyper-milling cutters are stored in the tool-cribs, and also shows a typical plywood container in which cutters are sent to and from the shop.

If cutters are reground at proper intervals, it will be found that many hours can be added to the life of the cutter tips and hundreds or thousands of parts machined before retipping is necessary. The grinding time can also be held to a minimum if cutters are sharpened in time. Cutters should never be used until they crater on the periphery of the cutting edge or land. Dullness can be easily detected and excessive cratering eliminated by periodically examining the tips. When a tip begins to turn black along the

(Concluded on page 197)

Fig. 9. Carbide-tipped Milling Cutters are Placed in Plywood Boxes for Transporting between the Tool-crib, the Machine Shop, and the Tool-room

The Bell

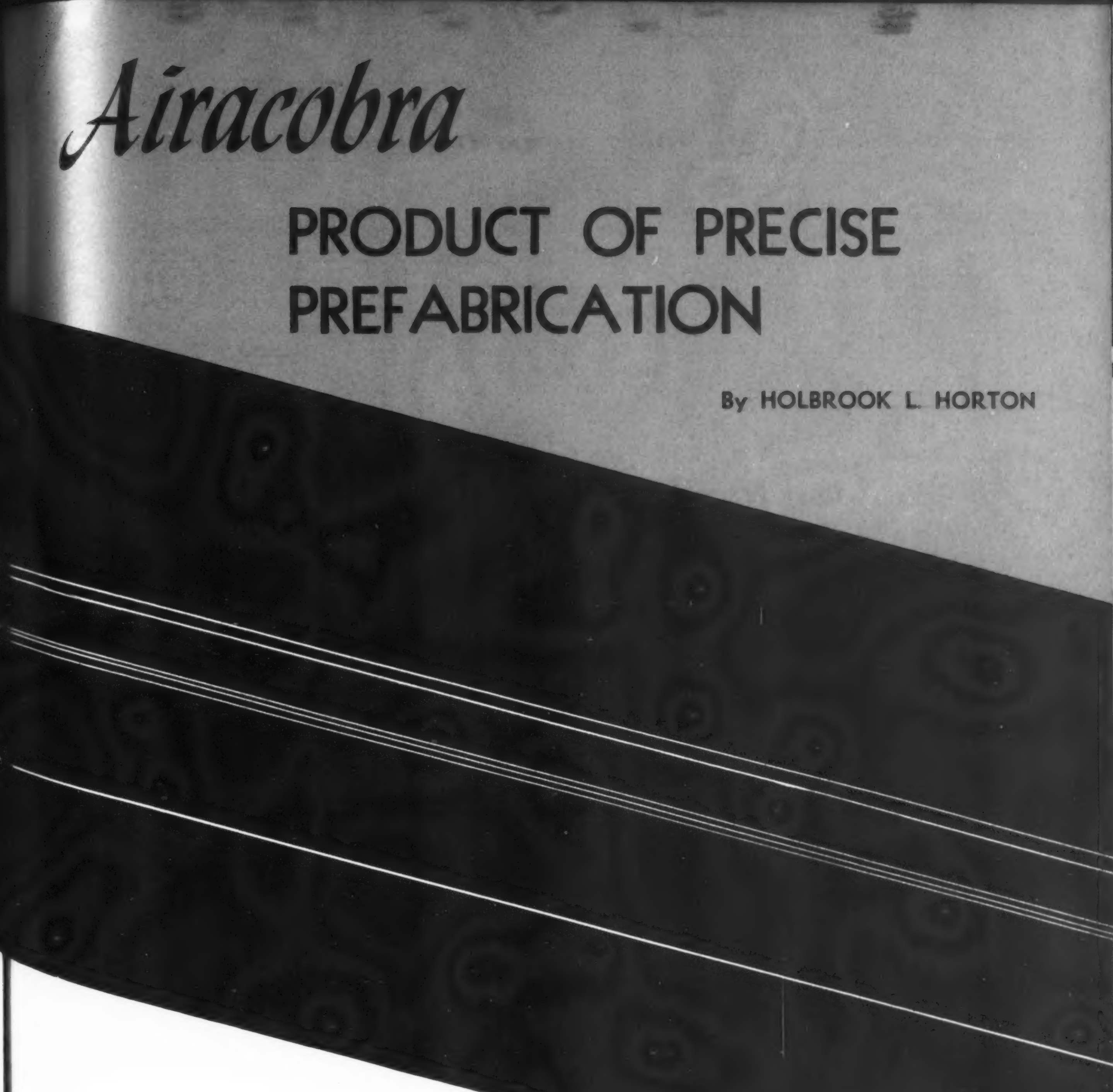
A SINGLE-SEATER fighter plane with "poison in its nose" is garnering the praises of United Nations' airmen on the battlefronts of East and West. This fast, hard-hitting craft—the Airacobra—has earned a reputation for deadly effectiveness against fierce and sometimes almost overwhelming opposition.

A feature of this plane is the 37-millimeter armor-piercing or explosive-shell firing cannon mounted in the center of the hollow propeller shaft. This, together with six machine guns mounted in pairs on the nose and wings, can deliver powerful blows to any plane within range and to many types of ground objectives as well. Hundreds of these planes are being turned out in Bell Aircraft factories to help provide the increasing numbers of combat aircraft required to tip the scales of air supremacy definitely in the United Nations' favor.

Down the continuously moving assembly lines, these planes are taking shape as former housewives, clerks, hairdressers, and women from every walk of life deftly fit and fasten the thousands of completely fabricated parts in place. This adaptation of a complex and highly precise product to the continuous production-line method of assembly by relatively unskilled workers is another triumph of the American genius for mass production.

Many factors have made this possible—far-sighted engineering and production planning, resourceful tool and fixture design, and a carefully planned fabricating and assembly plant lay-out. Another factor—by no means the least important—is the comprehensive application of lofting and templet die methods to the design and fabrication of the thousands of structural parts and skin sections required to make up the plane structure. Since many in the metal-working industry are not familiar with the practice of lofting and the use of templet dies, these methods will be described in some detail.

First attempts at lofting in aircraft design go back to the relatively early days when rough



Airacobra PRODUCT OF PRECISE PREFABRICATION

By HOLBROOK L. HORTON

lines were laid down to full scale on a large floor or loft for the metal-covered floats and hulls of seaplanes. Undoubtedly, these early attempts at full-scale lay-out were based on methods used in the age-old shipyard loft. With the advent of metal-covered streamlined airplanes utilizing fillets, fairings, tapered metal wings, fins, etc., aircraft lofting came of age. Here was a means of laying out complex, fair surfaces in such a manner that flat metal templets could easily be made for the fabrication of both tools and parts.

At the Bell Aircraft plants, the application of lofting has been carried out to the greatest possible extent. This lofting provides permanent full-scale outlines of the entire plane and its various sections, which serve as a reference and final authority for both engineering and production. About 90 per cent of the structural parts and skin sections of the Airacobra are laid out in the loft department, where about one hundred men and women are employed.

The actual procedure of lofting, as practiced at Bell Aircraft, is as interesting as it is un-

Fig. 1. Lofting Starts from an Engineering Sketch that Gives a Few General Dimensions of the Plane as Designed for Production

Fig. 2. The First Step in Lofting is to Lay out the Full-sized Contour of the Plane on the Loft Floor. Wooden Strips, or Battens, are Used as Guides in the Lay-out

usual. Starting with the basic design data, an engineering sketch of the plane, ready for production, is made, similar to that shown in Fig. 1. Only a few general dimensions are given to the lofting department by the engineering department—such as over-all length, spar, root and tip chord, sweepback, dihedral, incidence and air-foil section of both wing and empennage, together with aileron, flap, and spar locations. On the fuselage sketches, rough lines give the tentative location of frames, stringers, doors, decks, windows, and similar parts.

Based on these initial drawings and the general dimensions shown thereon, a full-sized outline of the plane is laid out on the loft floor, as shown in Fig. 2. The curved lines are drawn with flexible wooden strips, or battens, as guides, which have been carefully selected for straightness and uniform deflection. These are held in place by nails or lead weights, insuring smooth (or fair) contours. Permanent reference points on the loft floor, marked in inches, are used to establish the cross-sections of the fuselage.

The dimensions of the various cross-sections are next computed, and, taken together, these

FABRICATION

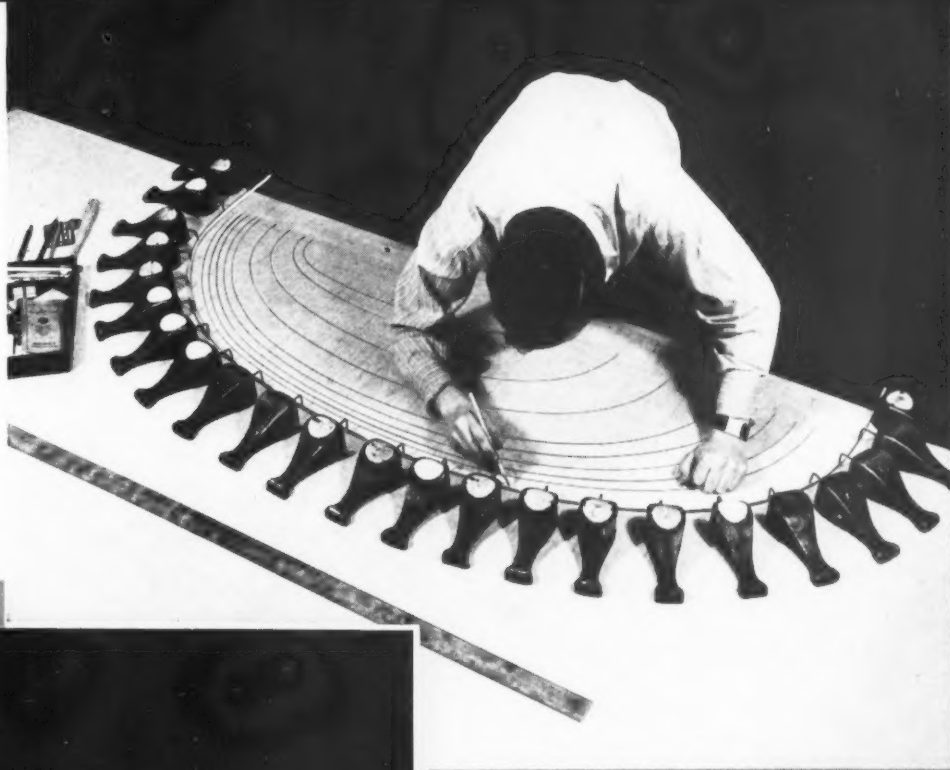


Fig. 3. After Computing the Various Cross-sectional Dimensions of the Plane, the Body Plan is Laid out and Scribed on Plywood

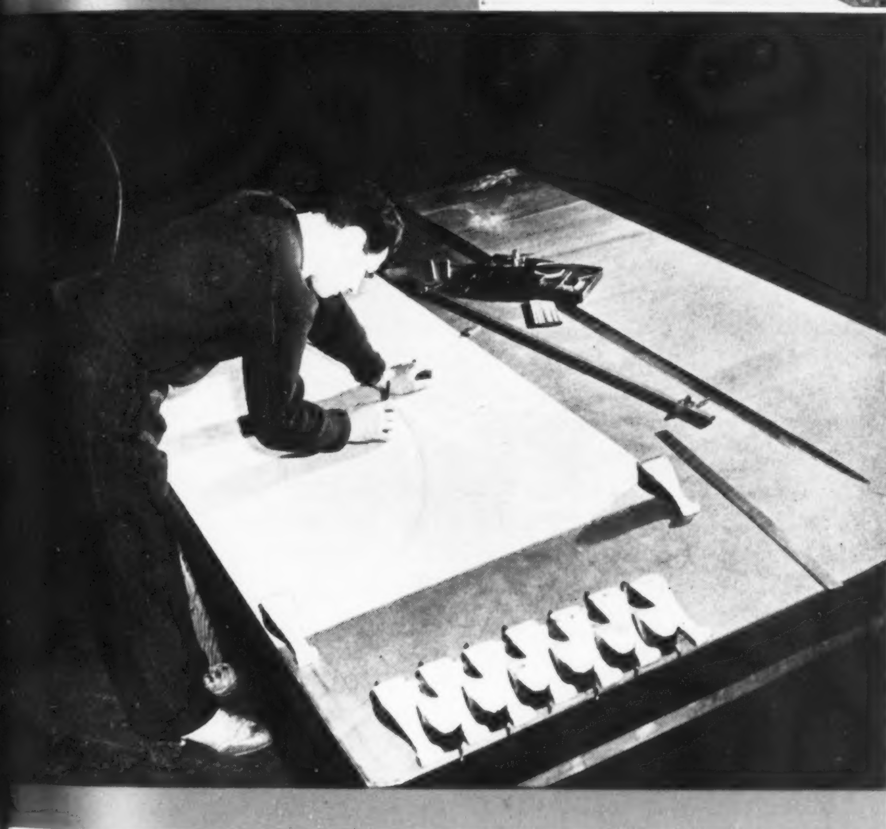


Fig. 4. Tracings are Made of the Body Plan for Submission to the Engineering Department, where Structural Analyses are Made and Basic Design Data Incorporated in Detail Drawings

cross-sections make up the body plan. One of the most difficult jobs is that of fairing or lofting the lines. Fairing, in some respects, is a trial and error process. It is accomplished by taking trial cuts from a body plan, plotting the points on the floor and examining the resulting contour. The points from the first attempt do not usually fall on a fair curve, but the loftsman decides on a mean fair curve that suits his eye. The revised points are transferred back to the body plan, and station contours are altered accordingly. Other cuts are taken and the process repeated until every cut will give a fair line and the body plans themselves are fair. As shown in Fig. 3, each cross-section is drawn to full size on plywood; and here, again, wood strips are used to provide fair curves. All lines are scribed into the plywood with a sharp knife to provide an accurate and permanent reference.

The detail drawings and templets required are then made directly from the body plan. A piece of vellum is laid over each section of the body plan, and the scribed lines are traced with a sharp pencil as shown in Fig. 4. Based on these vellum tracings, structural analyses are made, structural members are designed, and

BELL AIRACOBRA

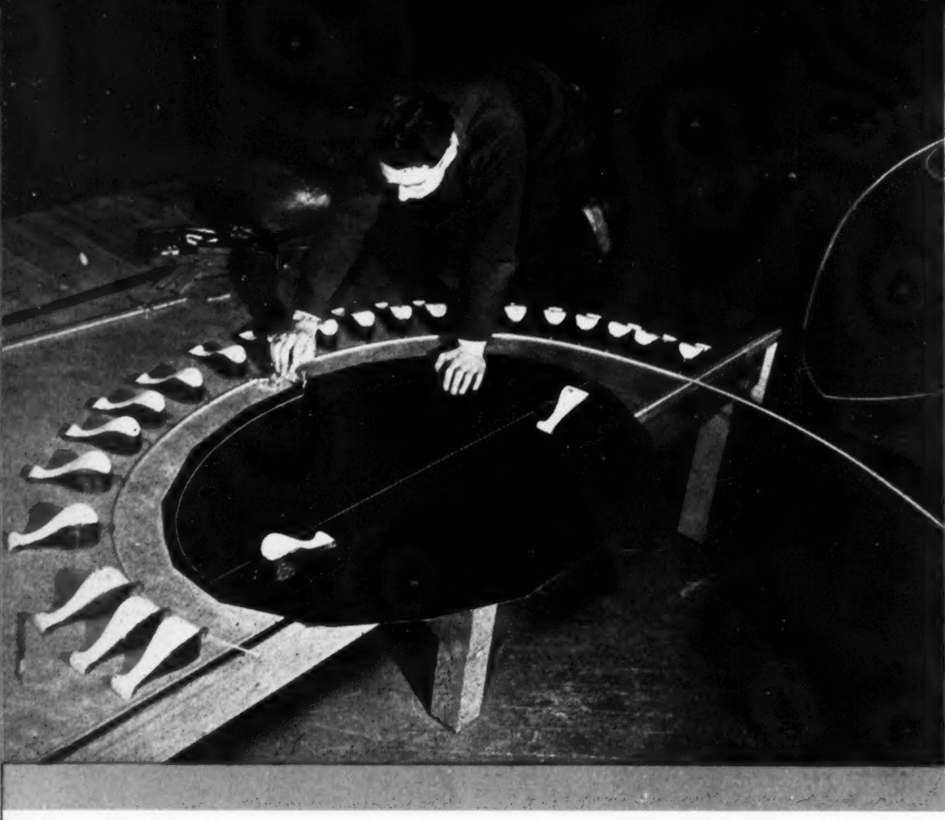


Fig. 5. Templet Lay-outs are Scribed on Metal Sheets by Using Wooden Guide Strips, Held in Place by Weights. Lay-out Tolerances are Kept within One-half the Width of a Finely Scribed Line

detailed engineering drawings are laid out, incorporating the basic design data.

Templets of 16- or 18-gage galvannealed sheet steel for each part of the airplane are made from the engineering drawings. Rivet holes and the location of lightening holes are drilled in the templet according to the engineering drawing. The basic dimensions for the templets are taken from the body plan, thus eliminating any chance for error. Dimensions or other data that will be required by the parts fabricator are stamped on the face of the templet for permanent reference.

The laying out of the templets, as shown in Fig. 5, is done with scribes, dividers, scales, and straightedges. This lay-out is surprisingly accurate, tolerances usually being held to one-half the width of a finely scribed line. Descriptive geometry is here applied as a fine art; bisectors, perpendiculars, and the like are all laid out geometrically. The master templet is laid out first, and this is retained by the loft department for reference. From this master templet, any number of duplicates can be quickly made for use in the shop.

There is a wide variety of types of templets made. The most common are the contour templet, used to set up and check dies, fixtures, and

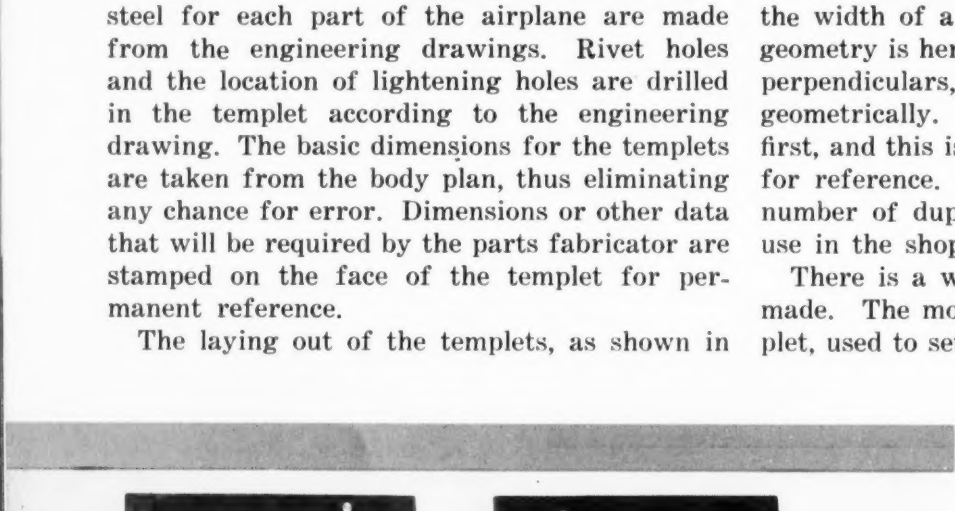


Fig. 6. Templet is Shown at Lower Right with Templet Die Above it. Work-piece is Shown at Lower Left with Punch Above it. Piercing Points are Inserted in the Die for Punching Rivet Locating Holes. The Six Small Holes Shown in the Work-piece are Drilled Later to the Size Indicated by the Templet

the like; the develop templet, which is a flat pattern of the part with developed flanges, coordinating holes, etc.; the apply templet, which is made to fit over a part that has been previously formed or extruded and is used to trim or drill it; the form-block templet, which is used to make the form block for the hydro-press or crank-press dies; and the router-block templet, which is used on the conventional routing machine to rout out parts.

One interesting fact about these templets is that, in practically every case where they are used, no blueprints are required by the workmen. Each templet serves as a complete set of instructions, so that even relatively unskilled men and women can be employed in the fabrication and assembly of the thousands of different parts required. The templet is also used in inspecting as a final check on the accuracy of the part produced. Usually, templets are made in sets that are matched one against the other, thus serving to prove the correctness of the templets and the engineering drawings from which they are made.

Examples of a templet, templet die, punch, and work-piece are shown in Fig. 6. Templet dies and punches are used by Bell Aircraft not only to cut and form the various skins and other parts, but to pierce the rivet locating holes as well. This saves much time in the subsequent hand-drilling of the holes to final size, and makes for greater accuracy. Of particular importance is the fact that any piece can be quickly re-

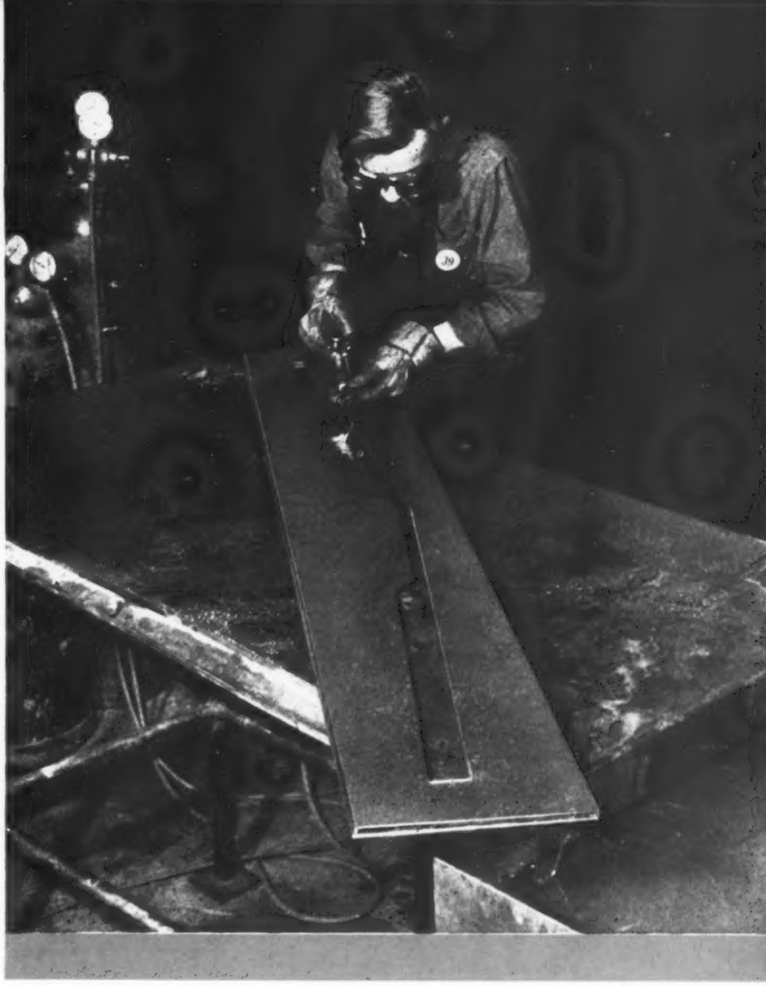


Fig. 7. Cutting Edges of Templet Dies are Flame-hardened by Oxy-acetylene Torch. A Water Jet Following Flame Provides the Quick Cooling Necessary. Both Dies and Punches are Welded to Back-up Plates, Eliminating Dowel-pins and Hold-down Screws

Fig. 8. This Massive 5000-ton Press is Operated Entirely by a Crew of Eighteen Women. Two Loading Tables are Alternately Rolled into the Feeding Position on Each Side of the Press

Fig. 9. Pantograph Router Designed by Bell Aircraft. Table is Long Enough to Permit Blanks to be Set up at One End while Routing is being Done at the Other. Templets are at Left of Center Rail and Blanks at Right

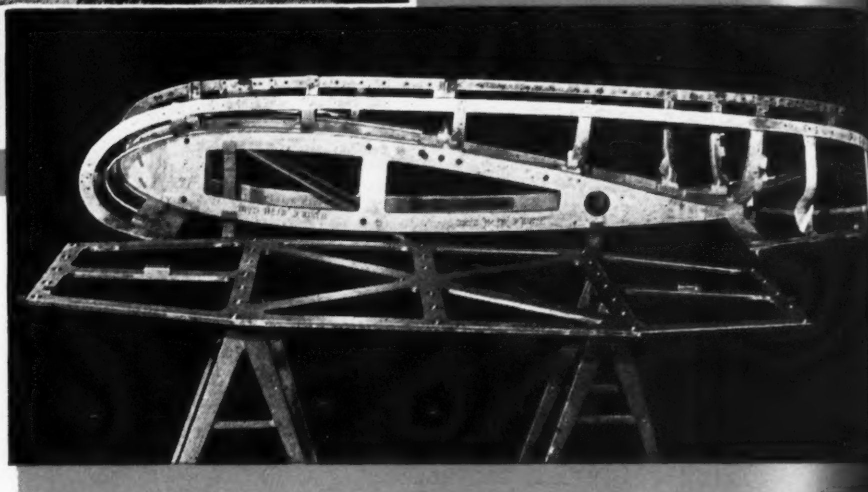


Fig. 10. In Front is a Master Drill Plate Used for Making Dies and Punches Interchangeable in Different Presses. In Rear is a Lofted Templet for Locating Fairing on Fuselage and Wing

placed, since each rivet hole in the replacing piece will have exactly the same location as that in the original.

The templet dies and punches are made of S A E 4130 steel ranging from 1/4 to 1/2 inch in thickness. They are backed up with cold-rolled boiler plate of 3/16- to 1/2-inch thickness. To obtain the necessary resistance to wear, the dies are flame-hardened along the cutting edge to a depth of about 1/8 inch and a hardness of about 52 Rockwell C, as shown in Fig. 7. The die shown is about 60 inches long. An oxy-acetylene torch is used with a water jet attached to the flame head. As the flame is moved along the edge of the die, a stream of water follows behind it, and, on striking the heated metal, provides the necessary quick quench for hardening. Owing to the difficulty of flame-hardening the numerous small holes of the punch into which the piercing points of the die fit, the entire punch is cyanided. The small piercing points are inserted in the dies and are made of hardened tool steel. Both dies and punches are welded to the back-up plates, thus eliminating the use of dowel-pins or screws.

By using this type of die, considerable tool steel is saved, together with the highly skilled labor that would ordinarily be required in die construction. Since the templet is an exact duplicate of the part to be produced, almost any good mechanic can take a templet and make a suitable die from it. Another advantage of this type of die is that, with the major portion of it unhardened, it has enough resilience to absorb a great deal of press shock without cracking.

As a general estimate, it may be said that the templet type of die requires only one-fourth as many man-hours to make as the standard type of die. Furthermore, the ease of arranging these dies in the press has reduced the set-up time so much that it has become feasible to produce small quantities of parts in this way with economical results.

In order to make sure that all templet dies will be interchangeable, no matter where they are used, a master drill plate, similar to that

shown in the foreground of Fig. 10, is employed for drilling the press locating holes in the dies. By using this master drill plate, the locating holes are always in the same relative position, so that every die can be moved from one press to another, or even to a different factory, and can be set up immediately.

In back of the master drill jig may be seen a lofted templet that is fitted up against the fuselage during assembly to give the proper locating points for fastening the fairing to the fuselage and wing. By using such a templet for drilling the fastening holes in the fuselage, the replacement of a damaged wing and fairing can be quickly effected in the combat theater without special fitting or drilling. This holds true for practically every one of the thousands of structural or skin members in the plane.

To further insure accuracy of assembly, some parts—for example, the fuel-tank cover—that have reinforcements or stiffeners are welded before blanking and piercing. The difficulty of lining up holes that are punched beforehand in parts that are to be riveted together is thus avoided.

In Fig. 11 is shown the skin for a wing gasoline-tank cover and the die used to blank it. The amount of time saved by piercing the rivet locating holes in one operation is clearly evident. The rubber pads customarily employed around the blanking edge of the die to aid in the shearing of the skin were removed previous to taking the photograph.

The proportion of women employed in the Bell Aircraft plants has been steadily increasing during the past year. One of the most interesting jobs being performed by women in these plants is the forming of various parts, such as bulkheads, ribs, stiffeners, etc., on a massive 5000-ton Lake Erie hydro-press. Fig. 8 shows one of the loading tables for this press; here the dies are located and the blanks placed over them preparatory to piercing and forming.

There are four such tables, two on each side of the press, and four women work at each table. When a table has been made ready, it is

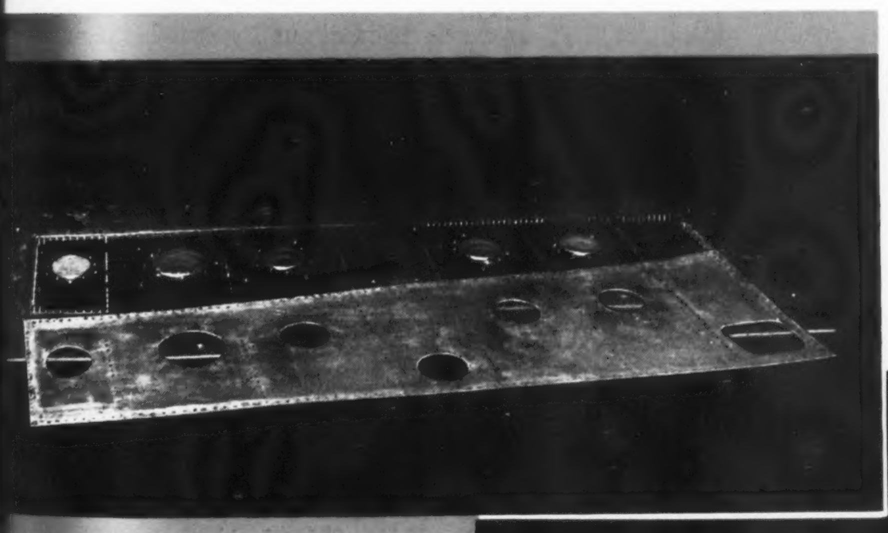
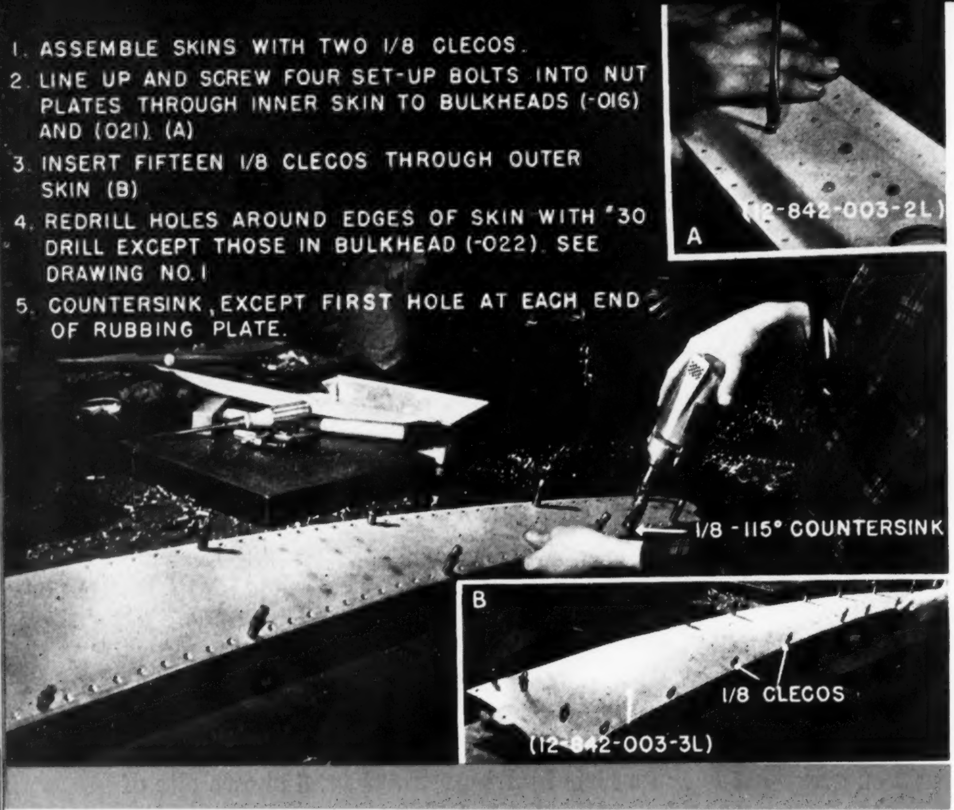


Fig. 11. Skin for Wing Gasoline-tank Cover and Die Used to Blank it. Much Hand Labor is Saved by Using Piercing Points for Locating Rivet Holes

Fig. 12. Two Drilling Heads, which are Mounted on Gantry Type Carriages, are Used for Stack-drilling Those Parts that are Not Pierced by Templet Dies



BELL AIRACOBRA

Fig. 13. Typical Visual Education Photograph Used to Guide Workers in Assembling. Each Step is Clearly Outlined and Correct Positions of Hands and Tools are Given. These Guides Save Much Supervisory Time

moved over by an electric motor to a position opposite the press, and the platform tray holding the dies and blanks is then moved underneath the ram. Two women operate the press, and the entire cycle of loading, forming, and unloading requires only one minute. The use of this press has speeded up the forming and piercing of small parts tremendously. A good many parts are also formed on drop-hammers.

Some pieces are cut on a pantograph router developed by Bell Aircraft, which is shown in Fig. 9. The templets are fastened to the table at the left, and as the tracing point moves along the templet edges, the router cuts matching parts from the stack of aluminum sheets at the right. This machine is about 50 feet long, and is capable of cutting three pieces of 1/8-inch stock or eight pieces of 1/32-inch stock at one time. The parts are cut out to an accuracy of within 0.005 inch.

In Fig. 12 are shown two Kingsbury drilling heads mounted on a gantry type of carriage being used for stack-drilling skin pieces not pierced in a press. Templets are used as guides. This stack-drilling arrangement was designed by Bell Aircraft.

A factor contributing to the ease with which unskilled labor is being trained to take its place on the production line is a comprehensive system of visual education by means of photographs. These photographs show the specific steps of each job in their proper sequence, and describe the correct way of performing them. A complete set of these photographs is main-

Fig. 14. Prefabricated Parts of Various Shapes and Sizes are Hung on Convenient Racks Ready for Assembly. Each Part is Ready to be Fastened in Place with a Minimum of Hand Work

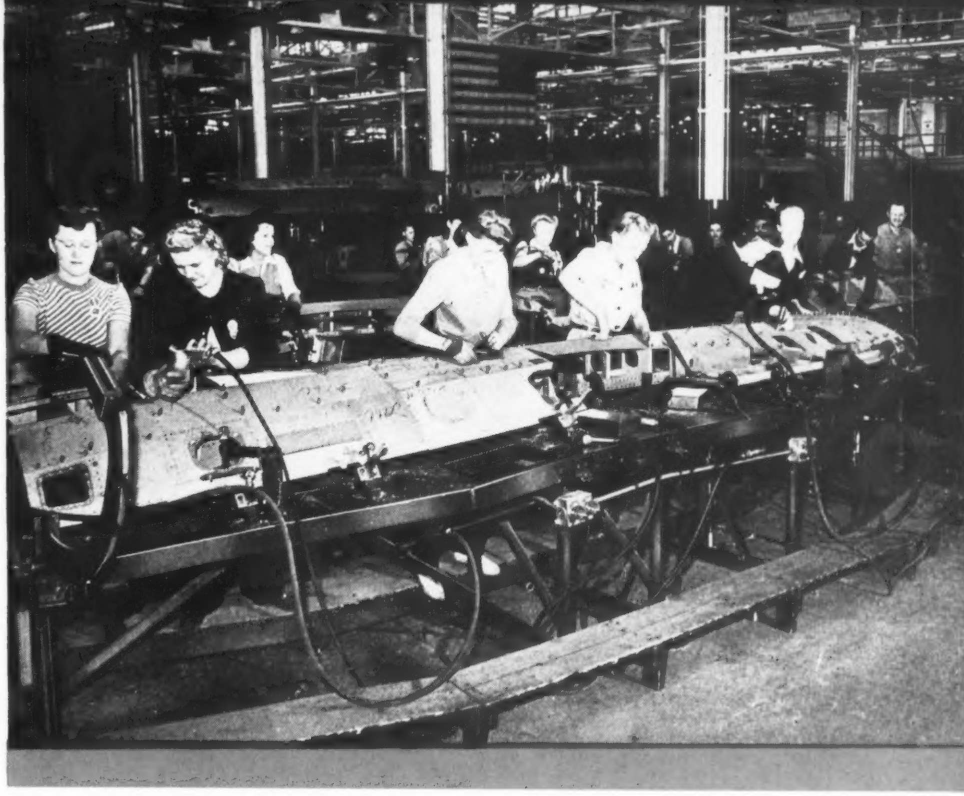


Fig. 15. Templet-die Blanked and Punched Pieces Fit Easily and Exactly into Assembly. Pierced Locating Holes are Enlarged by Hand-drilling to Receive Rivets while Parts are Held in Place by Cleco Fasteners

tained at each assembly point for quick reference. The supervisory load has been eased considerably by this method, assuring an answer to almost any question the worker may ask about the job procedure. A typical visual education photograph is shown in Fig. 13.

As shown in Fig. 14, at each assembly station, the parts required are held on conveniently located racks. Because of the extensive lofting and templet die preparation, the prefabricated pieces are complete and ready for assembly, with even the rivet holes accurately located. Expensive and complicated jigs are unnecessary. In watching the assembly of these parts into the plane, one gathers the impression that it is almost as easy as building a model with a child's prefabricated steel construction set.

The ease with which templet-die formed and punched pieces can be assembled is evident in Fig. 15. The piece with one end raised, in the center of this illustration, has been trimmed and punched flat by a templet die, yet the locating holes are placed so accurately that when it assumes the slightly curved contour required by the assembly, these holes will fall directly over the corresponding holes in the structural member to which the piece is attached.

Thus, with such careful and extensive planning for the production of accurate, interchangeable parts, the continuously moving assembly lines shown in Fig. 16 become the natural way to put these planes together. Airacobras are marching down these lines to the test flight field in ever increasing numbers.

Fig. 16. One after Another, These Bell Airacobras are Coming off Continuously Moving Assembly Lines, Ready to be Tested for Action on the World's Far-flung Battlefronts

Pioneer Makes

By CHARLES O. HERB

One of the Wartime Activities that Helped to Bring an Early Army-Navy Award to the Axelson Mfg. Co., Los Angeles, Calif., was the Mass Production of Aircraft Landing-Gear Struts

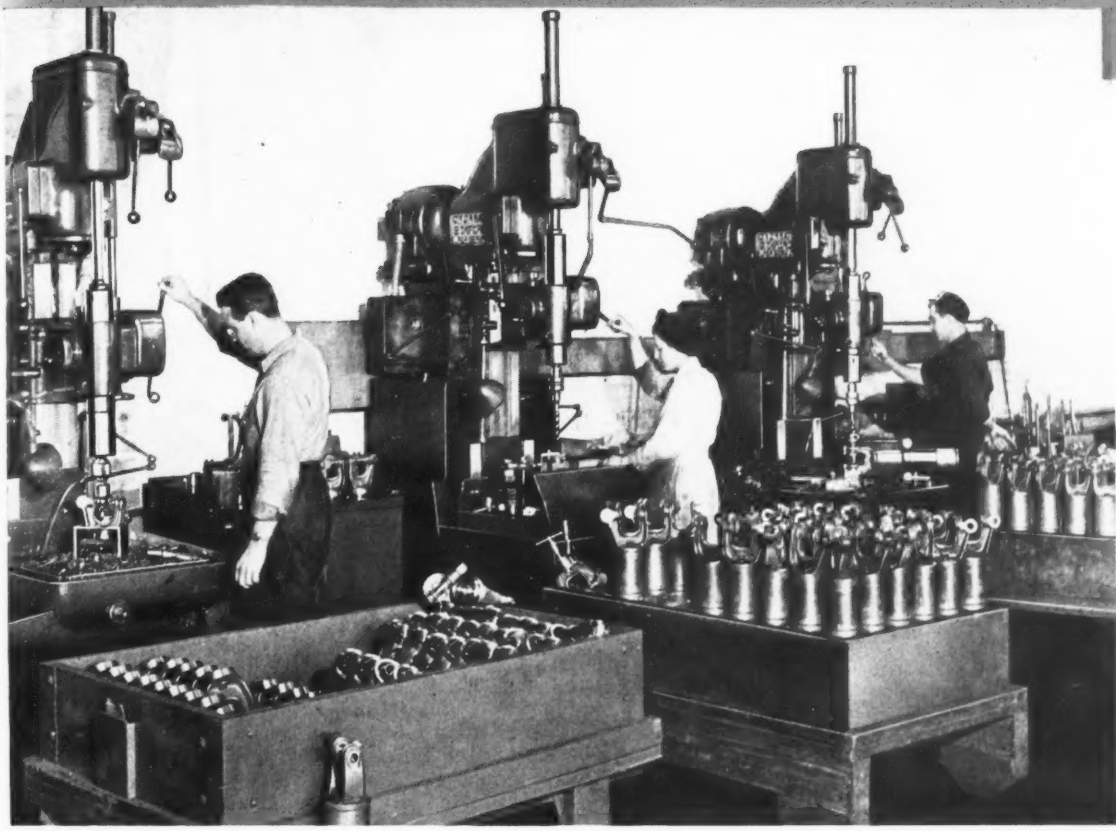
MORE than fifty years' experience in the manufacture of high-grade oil-well pumps and other equipment for the oil fields especially fitted the Axelson Mfg. Co., Los Angeles, Calif., for the production of landing-gear struts. Of especial value in planning strut manufacture was the experience gained in years of grinding and honing reciprocating-pump liners and plungers, operations that are analogous to those required in finishing strut cylinders.

The record established by this concern in manufacturing struts, as well as the high output attained in the building of engine lathes in a wide range of sizes, won the fourth Army-Navy Award to be given to a Pacific Coast concern, and the eleventh of these awards made to concerns in the entire country.

Strut manufacture in this plant entails the production of thirty-two individual parts and the performance of as many as fifty-four separate operations on one piece. Obviously, therefore, this article must be confined to operations on the more important details.

Manufacture of the inner and outer cylinders starts in the receiving department for raw materials where tubing for the cylinders is cut from long lengths by abrasive cut-off saws. These cut-off tubes, except the tubes that are to be fabricated into

Pacific Coast Shop Landing-Gear Struts

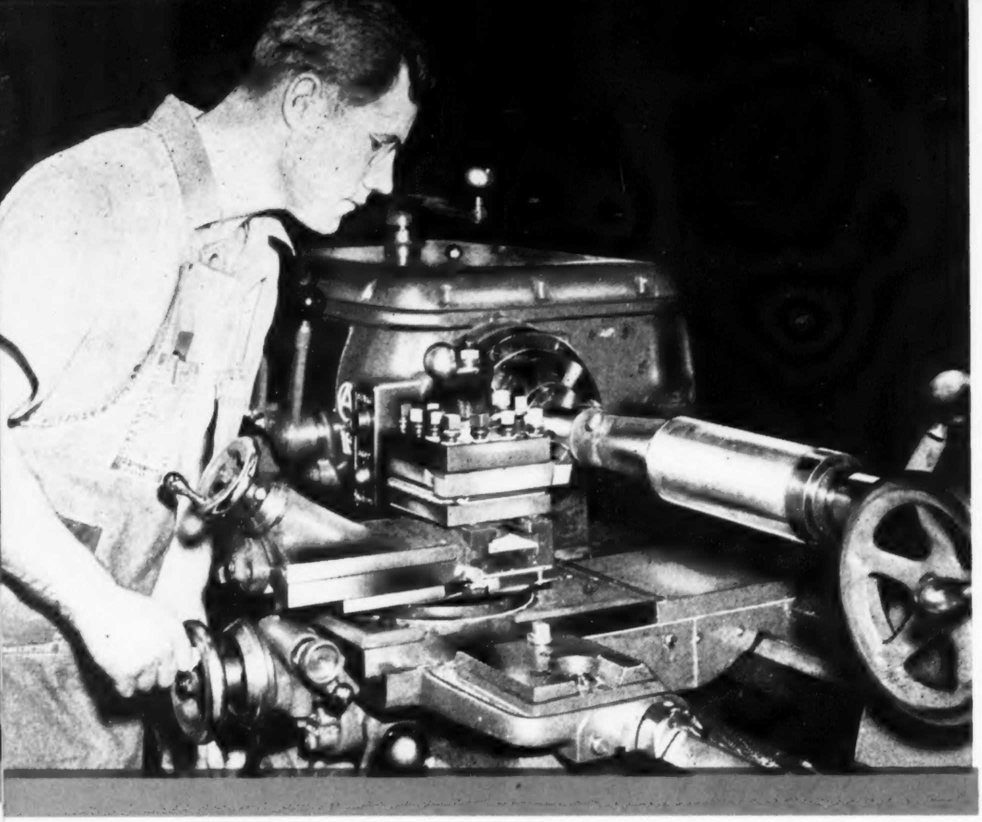


tail-wheel pistons, are sent directly to the machine shop. The latter must first be sent to another shop for swaging one end down to a considerably smaller diameter than the main portion of the cylinder.

Rough- and finish-turning of the tail-wheel piston assembly are performed on an Axelson 16-inch engine lathe set up as illustrated in Fig. 1 after the part has been given a preliminary rough-turning operation and then been heat-treated to about 350 Brinell. The headstock spindle of the engine lathe is provided with an adapter having a tongue that engages a slot in the clevis for driving purposes, and a clamp holds the clevis central with the spindle. The open end of the piston is supported by a conical ball-bearing center on the tailstock. The piston is bored before it comes to the lathe.

Only the straight portion of the piston is machined in this operation, the tolerance on the diameter being plus or minus 0.001 inch. As much as 0.032 inch of stock on a side is taken off in the first cut by the use of a Kennametal tool bit. The piston is made from S A E 4140 steel tubing. All together, twenty-eight operations are performed on this part before it is ready for assembly into a complete strut.

Another Axelson lathe being used for finish-turning the tail-wheel outer assembly is shown in Fig. 2. The bored open end of the cylinder is mounted on an expansion mandrel on the headstock spindle, while the clevis on the closed end is backed up by a short piece of round rod carried in a ball-bearing tailstock center. Several cylindrical surfaces and bevels ranging up to 5 inches nominal diameter are machined to specifications within plus nothing minus 0.001 inch. The operation is performed after rough-turning



MAKING LANDING-

Fig. 1. Turning a Piston Assembly for a Tail-wheel Strut after the Part has been Given a Preliminary Rough-turning and been Heat-treated to 350 Brinell

and heat-treatment, and again Kennametal tools are used.

A finish-boring operation on an inner cylinder for a front-wheel strut is seen in Fig. 3 being performed on an Axelson 25-inch lathe. This operation is also performed after heat-treatment. Rough-boring of the part is done in a set-up similar to that used in finishing, but, of course, prior to the heat-treatment. In both lathe operations, one end of the cylinder is clamped by an expanding adapter on the head-stock spindle, which is inserted in the tube, while the opposite end is held in a steadyrest.

Boring is also performed with a carbide-tipped tool on a bar that is mounted on a heavy block carried by the cross-slide. Approximately 0.063 inch of stock on the diameter is removed in finishing, 0.020 inch being left for removal by internal grinding and honing. As an indication of the great amount of work involved in manufacturing strut parts, it may be pointed out that a total of fifty-four separate operations are necessary in finishing this part alone.

Outer cylinders for front-wheel struts are ground internally in the Bryant chucking grinder shown in Fig. 5. Roughing and finishing cuts are taken in both the long cylinder bore, which is 3 7/8 inches in diameter by 14 inches long, and in the packing bore at one end, which is 4 1/4 inches in diameter by 3 1/2 inches long. The tolerance on both holes is plus or minus 0.0015 inch.

For this operation, a hinged ring is clamped around the body of the cylinder, as seen on the part standing at the front of the machine. This

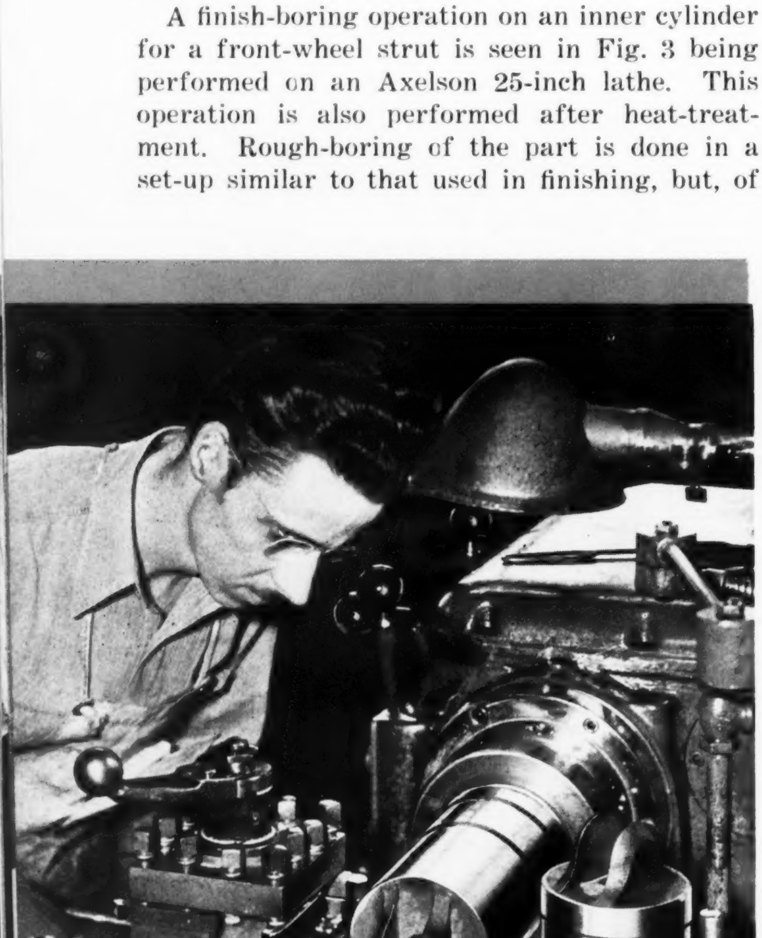


Fig. 2. Finish-turning Tail-wheel Outer Assembly. One End is Mounted on an Expansion Mandrel and the Other End Backed up by a Ball-bearing Tailstock Center

GEAR STRUTS

Fig. 3. Finish-boring an Inner Cylinder for a Front-wheel Strut by Employing a Lathe Equipped with a Steadyrest and with a Special Tool-block on the Cross-slide

ring is gripped between three jaws of an air-operated chuck, while the outer end of the cylinder is held in a steadyrest, which is shown open. An indicator gage, built into the machine, is employed to determine the progress in grinding the packing bore. This cylinder is made of S A E 4140 chromium-molybdenum steel, and is heat-treated to 350 Brinell. Thirty-five operations are required to produce this part, but before the development of the mass manufacturing methods now used, a total of sixty-two operations were performed.

Internal threads are milled in one end of the outer cylinder on the Lees-Bradner thread milling machine shown in Fig. 6. One end of the cylinder is gripped securely in an air chuck, and the end to be threaded is held in a steadyrest. The conventional type of multiple cutter is employed. The thread is milled to a diameter of 3 15/16 inches for a length of 3/4 inch, and there are 20 threads per inch.

The outer cylinders are honed, two at a time, on the Barnes upright hydraulically actuated honing machine illustrated in Fig. 4, which was built with four spindles for simultaneously honing four oil-pump liners of a smaller diameter than the strut cylinders. The cylinders are seated on a shoulder on locating sleeves at the bottom end, and are correctly positioned at the upper end by knurled bushings which fit into openings in the fixture.

Rough-honing is performed by one spindle and finish-honing by the second spindle, about 15 minutes being required to hone each cylinder to size within a tolerance of plus or minus 0.001

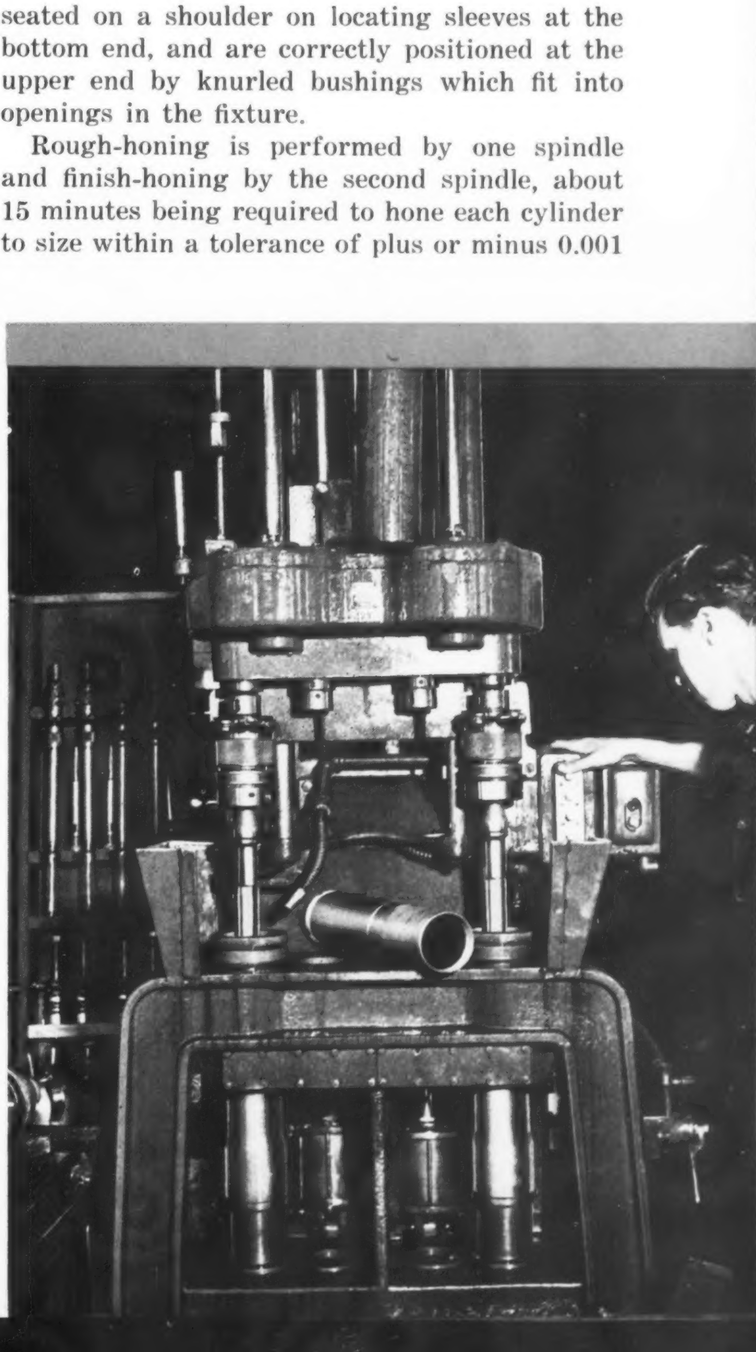
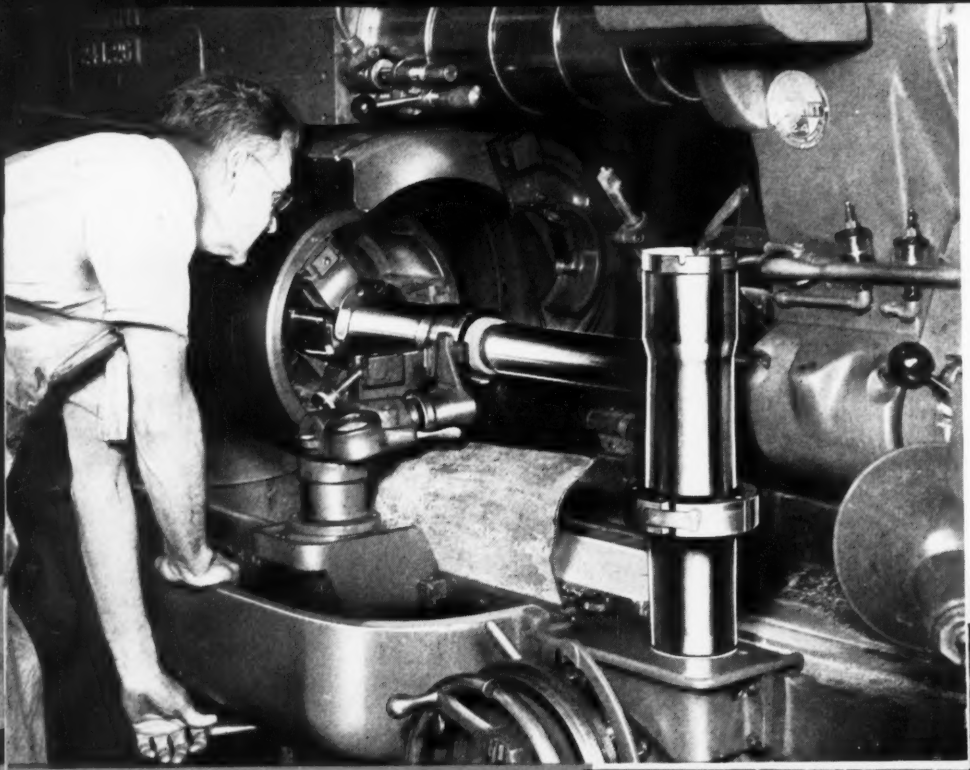


Fig. 4. Outer Cylinders are Honed to Size within Plus or Minus 0.001 Inch in a Hydraulically Actuated Machine of Upright Construction



LANDING-GEAR STRU

Fig. 5. Two Bores of Outer Cylinders for Front-wheel Struts are Ground to Size in a Chucking Grinder within a Tolerance of 0.0015 Inch

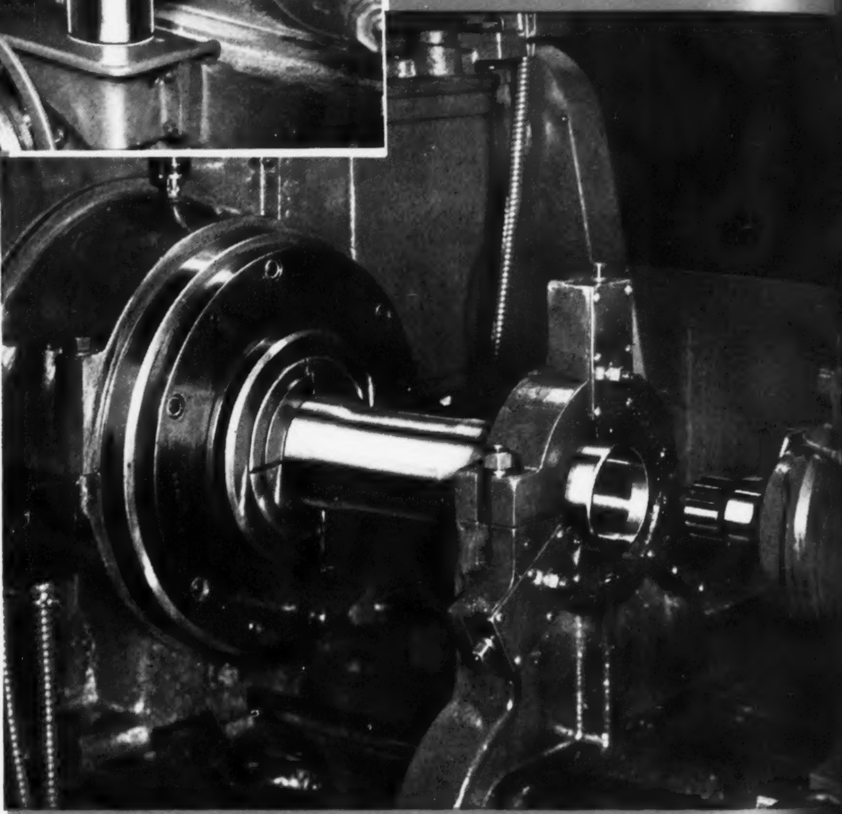


Fig. 6. Milling the Threads in One End of an Outer Strut Cylinder on a Standard Thread Milling Machine Provided with an Air Chuck

inch. The coolant used in honing is a mixture comprising 7 gallons of Toolcut oil to 55 gallons of kerosene. This is the final operation on the outer cylinder before assembly of the forged upper-end fitting and the inner cylinder.

High production in the rough-machining of the upper-end fittings has been attained through the application of a Bullard vertical turret lathe tooled up as shown in Fig. 7. This part is a chromium-molybdenum forging which comes to the machine in the rough, as indicated by the sample seen lying on the left-hand side of the table. It leaves the vertical turret lathe in the bored, turned, and faced condition shown by the part in front of the fixture.

In this operation, the piece is first rough-turned by a carbide-tipped tool mounted on the side-head, which takes a cut that varies from 3/16 to 1/4 inch in depth. Next, a hole is drilled in two steps to a diameter of 1 9/16 inches and a depth of approximately 3/4 inch by drills on the turret. Then the hollow mill seen at the upper left on the turret is employed for counter-boring to diameters of 3 1/8 and 1 15/16 inches.

Tools on the side-head are next used for facing the central boss and the outer ridge that surrounds the recess, after which chamfering cuts are taken with the remaining tools on the turret. All the side-head tools and the chamfering cutters are carbide-tipped. The surfaces rough-machined in this operation are later finished on an engine lathe to specified dimensions within plus or minus 0.0015 inch.

The ears on the end fittings that are welded to the inner cylinder assemblies are ground on the inside surfaces in close relationship with the axis of the part and also within a close tolerance as to the width of the slot. This operation is performed on an Abrasive surface grinder set up as shown in Fig. 8.

The work is clamped from the externally ground outer surface after the ears have been properly located by means of gage-plugs that are inserted through holes provided in brackets fastened to the front and back of the fixture. A gage-block that is permanently fastened to

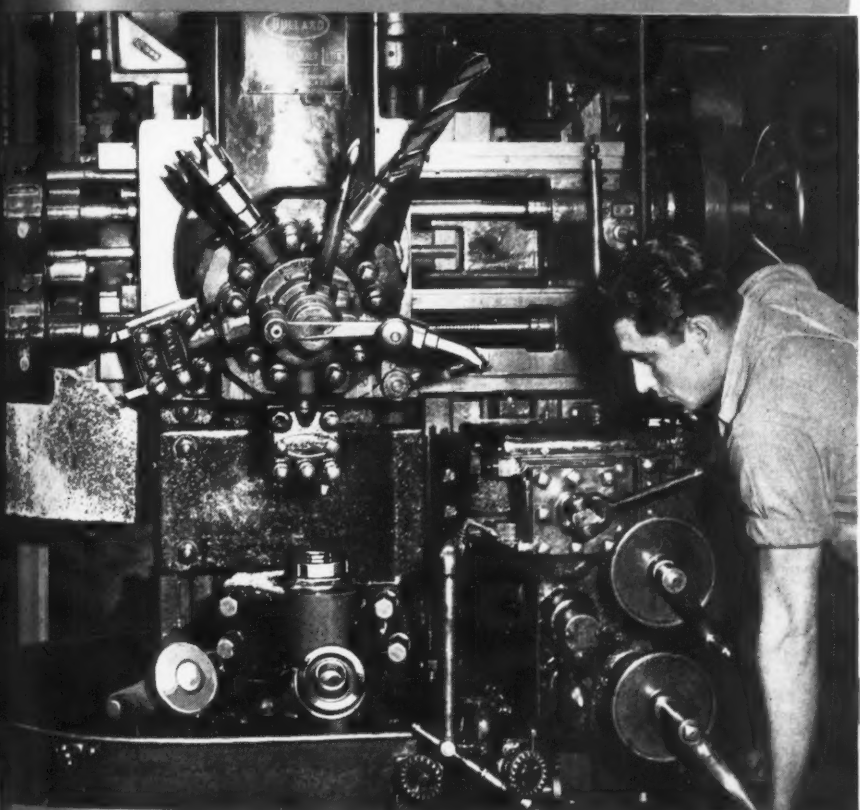
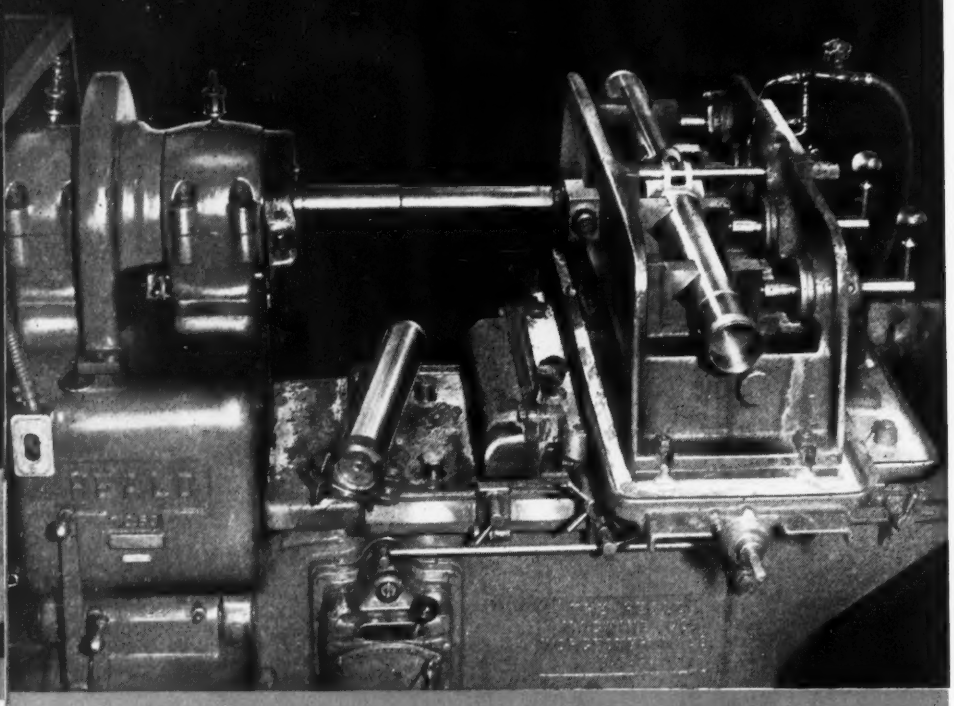


Fig. 7. The Forged Fittings that are Welded to Outer Cylinder Assemblies for Nose Struts are Completely Rough-machined in One Operation on a Vertical Turret Lathe

Fig. 8. Grinding the Ears on the Forging that is Welded to Inner Cylinder Assemblies Accurately with Respect to Axis of Part



MAKING LANDING-

Fig. 9. Two Inner Cylinders are Ground at One Time in the Half-bearing of the Forging that is Welded to One End of These Cylinders by Employing the Internal Grinding Machine Here Shown

the fixture is used in lining up the table with respect to the grinding wheel. About 0.010 inch of stock is ground off each ear to correct distortion resulting from heat-treatment. The outside surfaces of the ears are milled before the heat-treating process, and are sufficiently accurate when the parts come to this machine.

A bolt-hole is drilled at an angle through one of the bosses on the same forging by employing a Cincinnati Bickford radial drilling machine set up as illustrated in Fig. 10. The ground faces of the half-bearing on the forging are seated on hardened and ground blocks of the fixture to obtain the proper angle of inclination, and the cylinder is further located by passing a ground plug through a hole that was previously drilled and reamed through the ears. This plug also passes through a hole in a block that is integral with the fixture. The hole drilled in this operation is 29/32 inch in diameter and extends through about 1 3/4 inches of stock.

The half-bearings on the forging at one end of the inner cylinders are ground to match cap bearings by applying the Heald internal grinding machine shown in Fig. 9. Two cylinders are placed in the machine at one time, pointed in opposite directions so as to make one complete circle for the grinding wheel to operate in rather than only a half circle, as would be the case if but one cylinder was ground.

The work-pieces are held in an Axelson designed fixture equipped with two long rods that are slipped through bushed fixture holes and the ears of both cylinders for locating purposes. Then clamps with V-blocks are tightened against

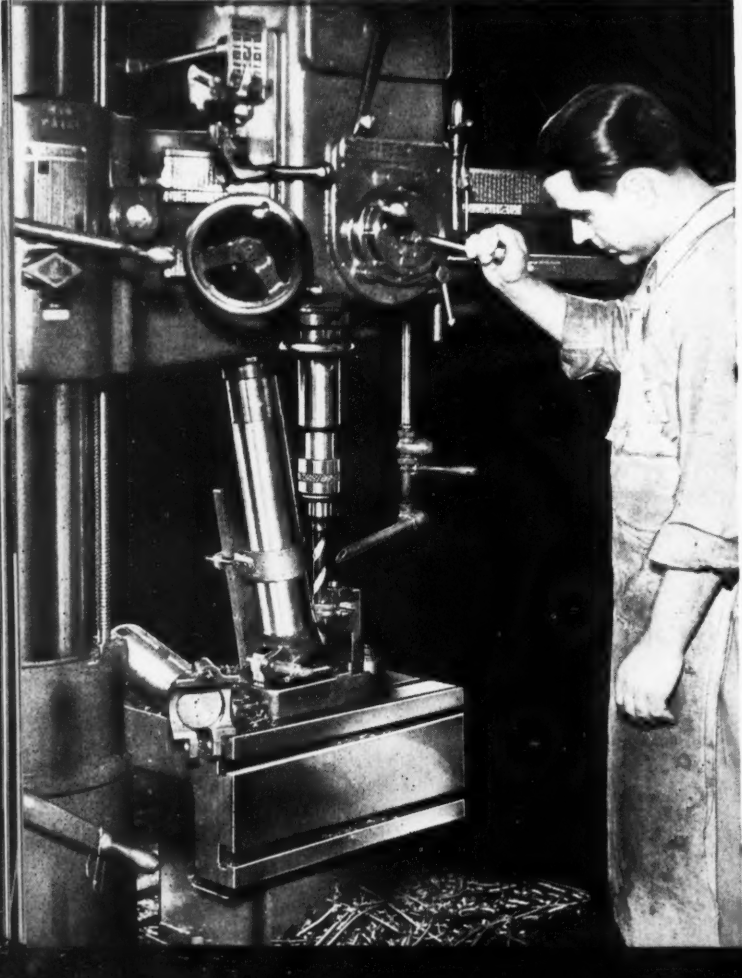


Fig. 10. Employing a Radial Drilling Machine for Producing a Hole in the Forged End of Inner Cylinder Assemblies at an Angle with Axis of Part

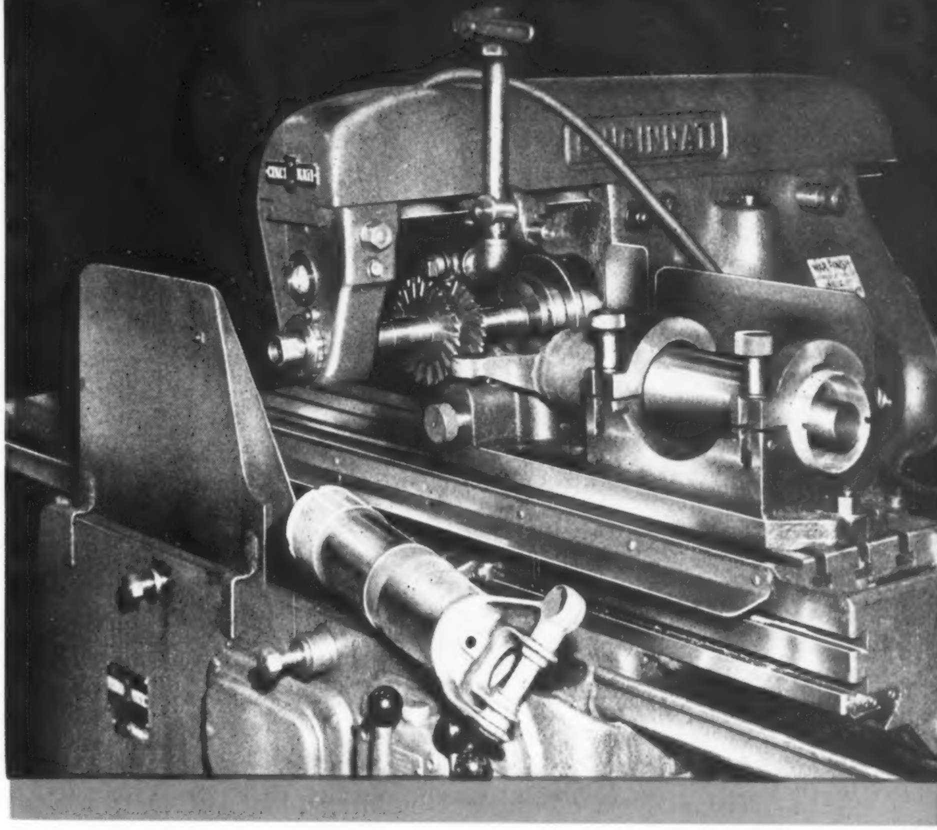


Fig. 11. Cutting "Spreader" from between the Ears on Inner Cylinder Assemblies in a Milling Operation that Involves the Use of Two Narrow Cutters and a Special Work-holding Fixture

one side of the cylinders to force them against stationary V-blocks on the opposite sides.

The bearings are ground to a nominal diameter of 3 1/2 inches within plus or minus 0.002 inch. A 3-inch wheel is used. The bearing caps are also ground with the same equipment.

A typical milling operation in strut manufacture consists of cutting a "spreader" from between the ears on the forging that is welded to one end of outer cylinder assemblies. This operation is shown in Fig. 11. The "spreader" is provided to prevent excessive distortion of the ears during heat-treatment. The cylinder is located from finished external surfaces for the milling operation, and the "spreader" is cut out by two milling cutters, 1/4 inch wide by about 6 inches in diameter. The ears are supported by spring-backed buttons, which are clamped solidly for the operation.

After this "spreader" removing operation, the ears are drilled on a Cincinnati Bickford upright drilling machine set up as shown in Fig. 12. A two-step drill is employed, as the bottom ear must be drilled to a diameter of 7/8 inch for a depth of about 1 inch and also to a diameter of 3/4 inch for an additional depth of 1 inch. The ears are drilled through first to the smaller diameter and then enlarged to 7/8 inch, with one down feed of the drill.

After the drilling operation, the holes are reamed in the same set-up, and the small-diameter hole in the bottom ear is tapped. To facilitate substitution of tools, the machine is provided with a McCrosky quick-change chuck. The operation is practically the last one on this part.

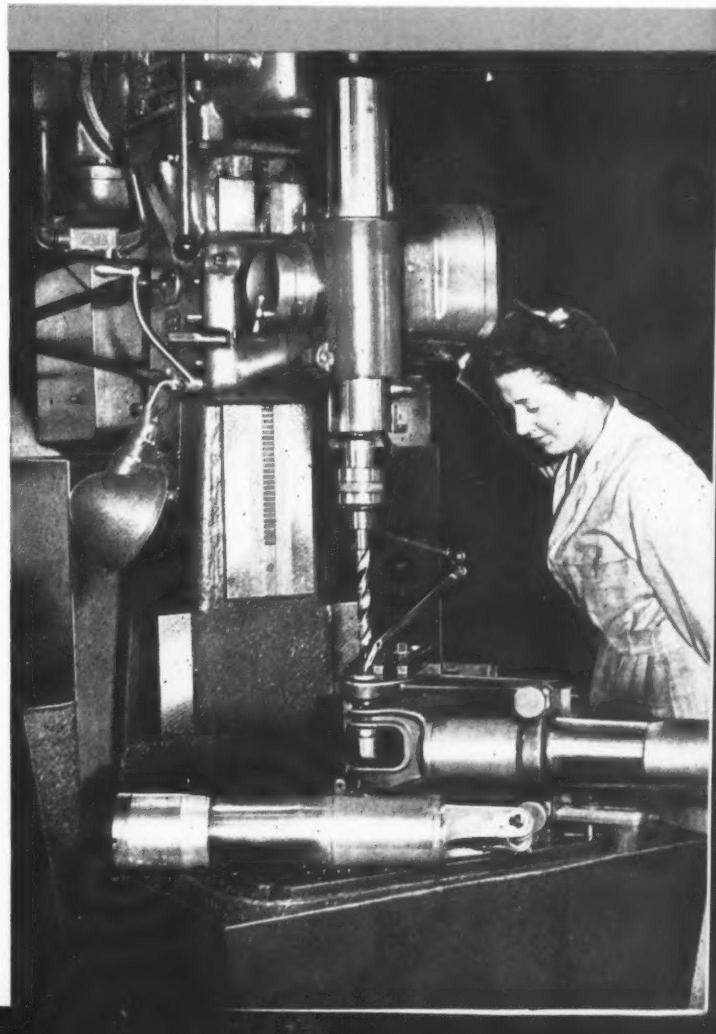


Fig. 12. Drilling Operation on Outer Cylinder Assemblies in which a Two-step Drill is Employed for Drilling to Two Diameters in One Set-up

Building Douglas "Wings for Victory"

Outstanding Operations in One of the Aircraft Industry's Best Equipped Machine Shops

By CHARLES O. HERB

GREAT changes have occurred in the machine shops of airplane-building plants since the demands of the second World War necessitated the mass production of bombing, fighting, and transport planes. Instead of being a department of relatively minor importance, as in the earlier days of the industry, the machine shop today is one of the foremost departments in large airplane-building plants. Managements generally have been more than willing to provide the finest machine tool equipment available.

The machine shop in the Long Beach, Calif., plant of the Douglas Aircraft Co., Inc., is conceded to be one of the best in the aircraft industry, both from the standpoint of the equipment and the methods followed. Outstanding operations in this shop were described in articles published in MACHINERY last year; the present article will deal with unusual methods developed since then.

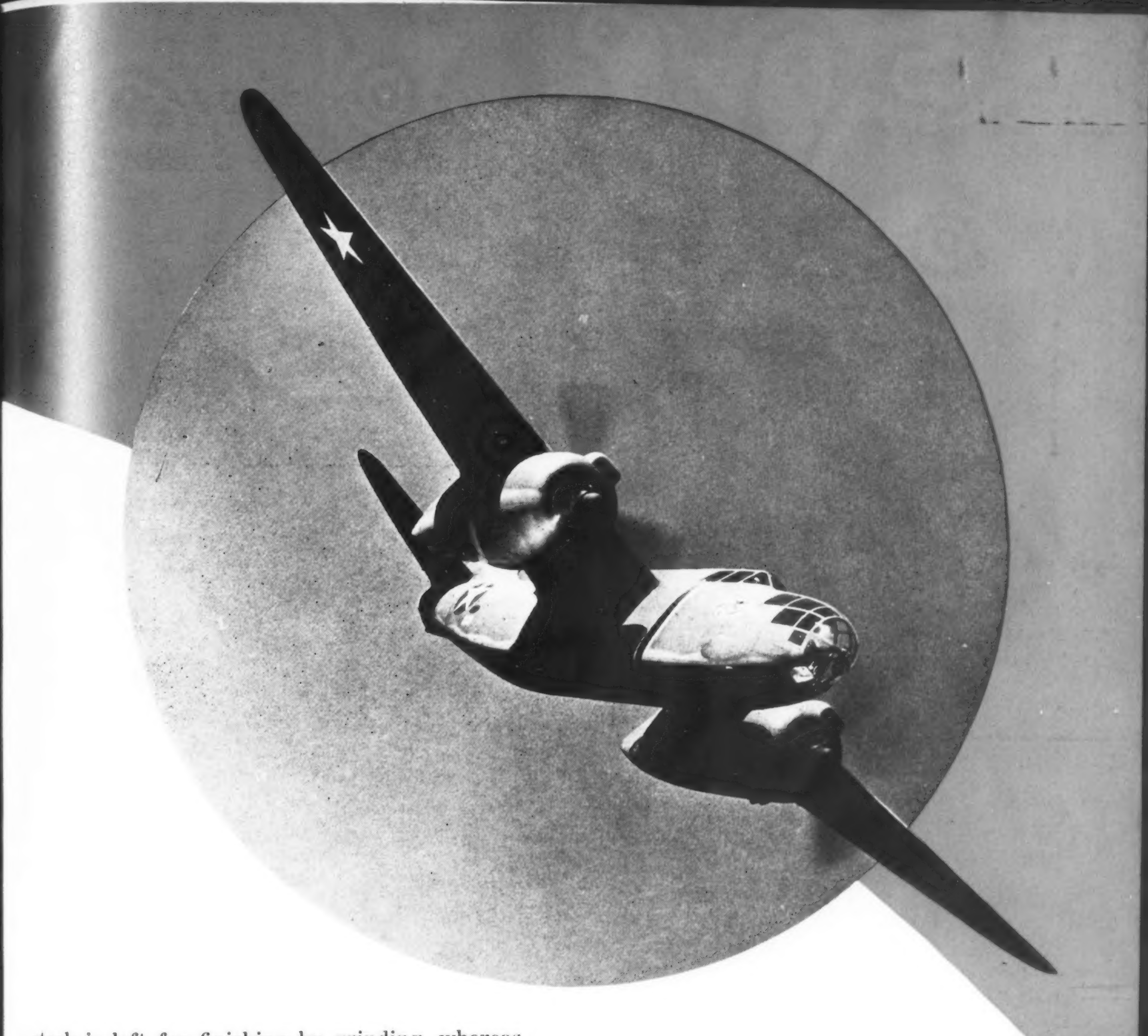
Fly cutting with tungsten- and tantalum-carbide tool bits is coming increasingly into vogue. The fine finish and accuracy obtained with cutters of this type in machining aluminum has led to their fairly extensive adoption in finishing steel parts. This practice brings important economies in milling and grinding time, in addition to the advantage of high quality work.

Fig. 1 shows a particularly good example of fly cutting on a Lucas horizontal drilling, boring, and milling machine. The operation consists of facing the steel weldment for a subassembly jig. The jig member is 61 inches high by 57 inches wide over all, and the surfaces being faced are 13 inches wide.

Roughing cuts are taken with a Kennametal tool to a depth of 1/16 inch, using a surface feed of 0.008 inch per revolution of the cutter. The latter is positioned at a radius of 12 1/2 inches from the center of the spindle, and is revolved at 82 R.P.M., so that it moves around a circle at a speed of approximately 350 feet per minute. The cutting edge is ground to a negative rake of 10 degrees. After the jig face was completely machined in this operation, it was finished on a large surface grinding machine.

A hyper-milling operation is shown in Fig. 2 in progress on terminal plates of chromium-molybdenum steel, which are cut out by an oxy-acetylene torch machine. The cutter-head is equipped with four Kennametal tool bits which are adjusted to different heights, so that four cuts are taken simultaneously as the work feeds past the cutters. These cutters are also ground to a negative rake of 10 degrees. On the work seen lying on the table in front of the fixture, ridges left by the four cutters can be seen along the left side of the finished surface. Two feed movements of the work past the cutters are required, as the cutters face only half the width of the surface at a time. Roughing and finishing cuts are taken.

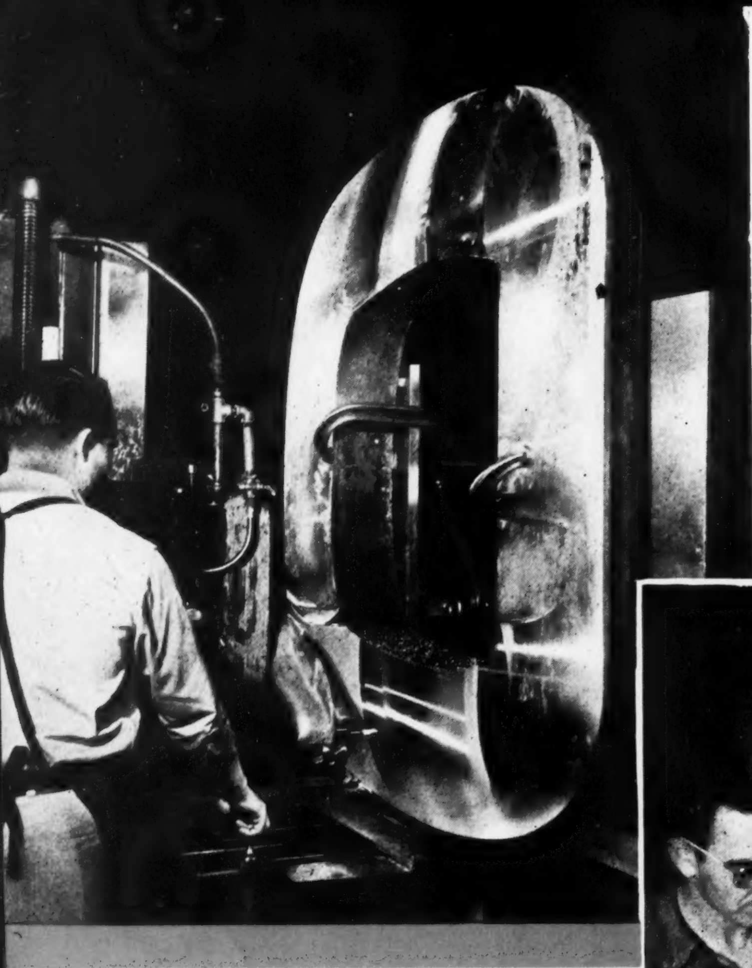
In roughing, the four cutters face to a total depth of 5/16 inch at a feed of 4 1/4 inches a minute, so that it takes only about 2 3/4 minutes to complete the 9-inch cut. The cutter-head is run at a speed of 357 R.P.M., and as the diameter across the tool bits is 4 inches, this gives a rotary cutter speed of 365 feet a minute. The chips come off red-hot, but the work remains cool to the touch. Only 0.005 to 0.007 inch of



stock is left for finishing by grinding, whereas when the pieces were faced by the method previously used, it was necessary to leave from 0.040 to 0.050 inch of stock for grinding. Two fixtures are provided on the Cincinnati milling machine on which the operation is performed, so that a piece of work can be loaded while another is being machined.

All the tools used on the cutter-head are ground to the same length, the slots in the cutter-head being of different lengths, so as to automatically position the tools at the required heights when they are assembled in the slots. Because of this provision, all tools can be changed and ready for use within 1 1/2 minutes. It takes only 1 1/2 minutes to grind the tool bits, whereas 1 1/2 hours was necessary for regrinding the cutters employed in the previous method of finishing the terminal plates. The tool bits last for from five to six pieces between grinds. Ground tool bits are kept on hand, ready for immediate replacement.

When the part has been faced to the required width, a cutter-head of the type seen on the machine in Fig. 3 is substituted for cutting away the ridges left by the tools in the preceding operation. In this case, only one tool is employed. It is ground to a radius on the cutting edge for machining a fillet on the work. Only one cut is necessary, and it is taken at a feed of 7 1/4 inches a minute, with the cutter-head running at 840 R.P.M. The entire cut is taken in a little over 1 1/4 minutes. With this method of machining, it is not necessary to grind the fillet, as was the case with the method previously employed. The fillet-facing cutter machines twelve to twenty pieces between grinds.



MACHINE SHOP OPERATIONS

Fig. 1. Finishing the Face of a Large Steel Weldment for a Sub-assembly Jig by Employing a Fly Cutter on a Horizontal Boring, Drilling, and Milling Machine

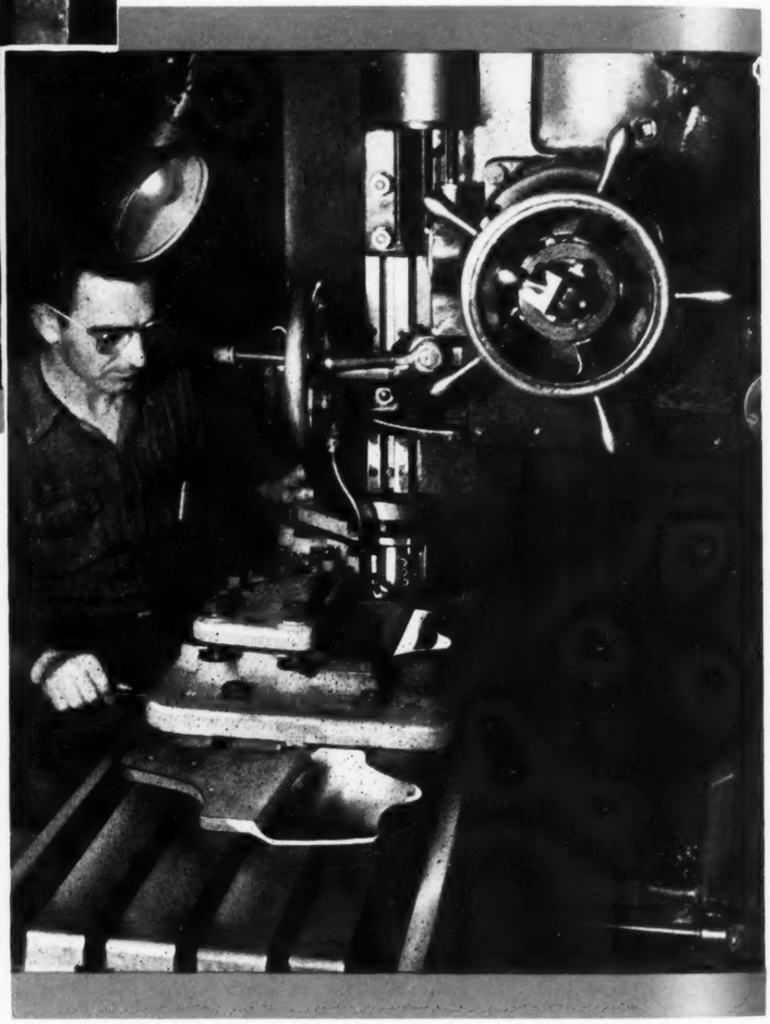


Fig. 2. Hyper-milling has Greatly Speeded up the Machining of Chromium-molybdenum Steel Terminal Plates and Reduced the Grinding Time in the Final Operation on These Plates

In taking turning, drilling, and reaming cuts on terminal forgings in a turret lathe, trouble was experienced in gripping the square end of the forging accurately enough to insure concentric rotation of the shank end. To correct this condition, the three steel jaws of the chuck were replaced with two heavy Kirksite jaws, constructed as shown in Fig. 4. These jaws are operated by the regular chuck screws. They give a purchase on all four sides of the square section of the forging, and as the jaws are about 4 inches thick, they exert a gripping pressure over a substantial area.

In chucking a terminal forging, the square end is inserted into the two jaws and the overhanging end is supported temporarily on a bell center on the turret to hold it in alignment with the headstock spindle. Then the chuck jaws are

tightened, after which the bell center is withdrawn and the operation started. Should this operation become obsolete, the Kirksite could be salvaged for other applications.

A unique method of holding landing-wheel bearing retainers for grinding an internal thread is illustrated in Fig. 5. The headstock spindle of the Jones & Lamson thread grinding machine on which the operation is performed is provided with a special adapter. The bearing retainers, one of which is seen lying on the tray at the front of the machine, are slipped, one at a time, sidewise into the adapter through an opening in the cylindrical wall. Then the second device seen lying on the tray is slipped on the end of the adapter, the large outer bore of this device being ground to fit the outside of the adapter. The inner ring of this device seats in

Fig. 3. A Second Hyper-milling Operation on Terminal Plates, in which the Ridges Left by the Four Cutters in the Preceding Operation are Cut away and a Smooth Fillet is Obtained

Fig. 4. Two Kirksite Chuck Jaws Substituted for the Regular Jaws Enable Terminal Forgings to be Handled Efficiently on a Turret Lathe

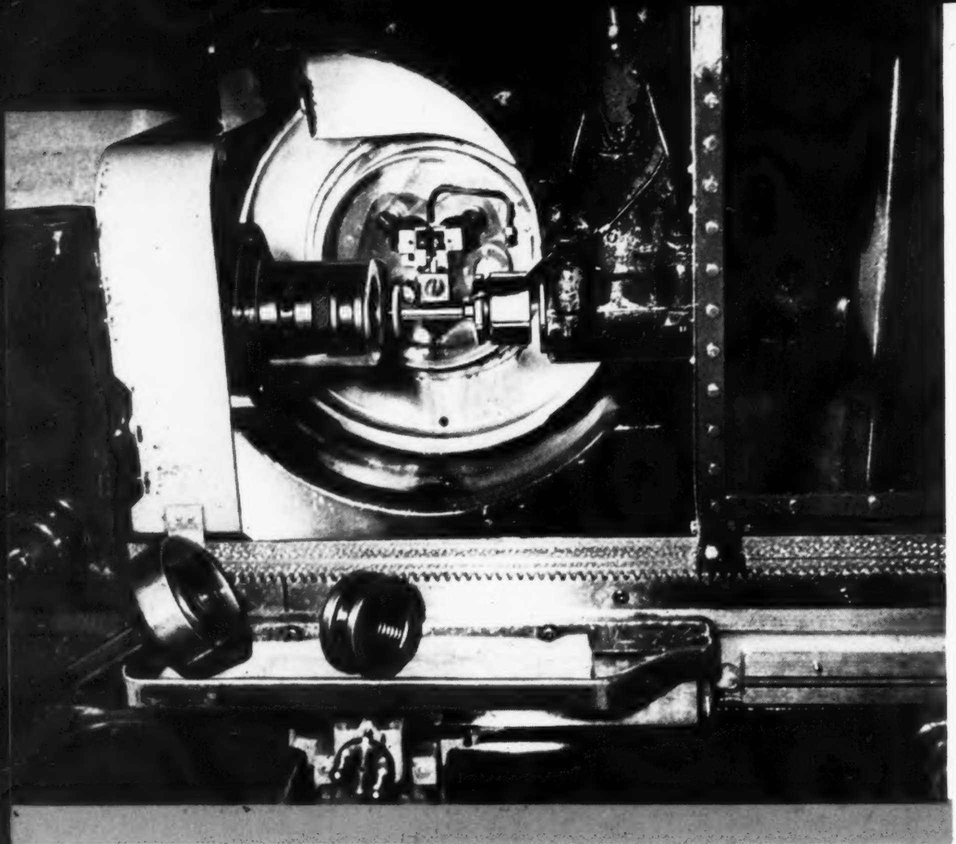


Fig. 5. An Ingenious Work-holding Adapter Facilitates Grinding an Internal Thread in Landing-wheel Bearing Retainers

the bore of the retainer and centralizes the retainer with the headstock spindle.

With the work-piece thus located, a large knurled nut on the inside of the adapter is tightened against one face of the retainer so as to force the opposite face against the front wall of the adapter. Then a threaded sleeve in the center of the adapter is turned by means of a rod, which is applied in the manner of a spanner wrench to advance a shoulder at the front end of the sleeve into the retainer bore. The work-locating device is then removed from the front of the adapter and the operation started.

The thread is ground to the specified pitch diameter within plus 0.0047 inch, minus nothing, for a width of about 1 inch. When the operation starts, a guard with a glass window mounted on rollers that run along the bed of the grinding machine is pushed in front of the revolving work. The progress of the operation can be closely observed through the window.

The milling of bosses on motor mount rings has recently been speeded up by the specially designed fixture seen in Fig. 6, and the use of two milling cutters for simultaneously finishing opposite sides of the bosses. The operation is

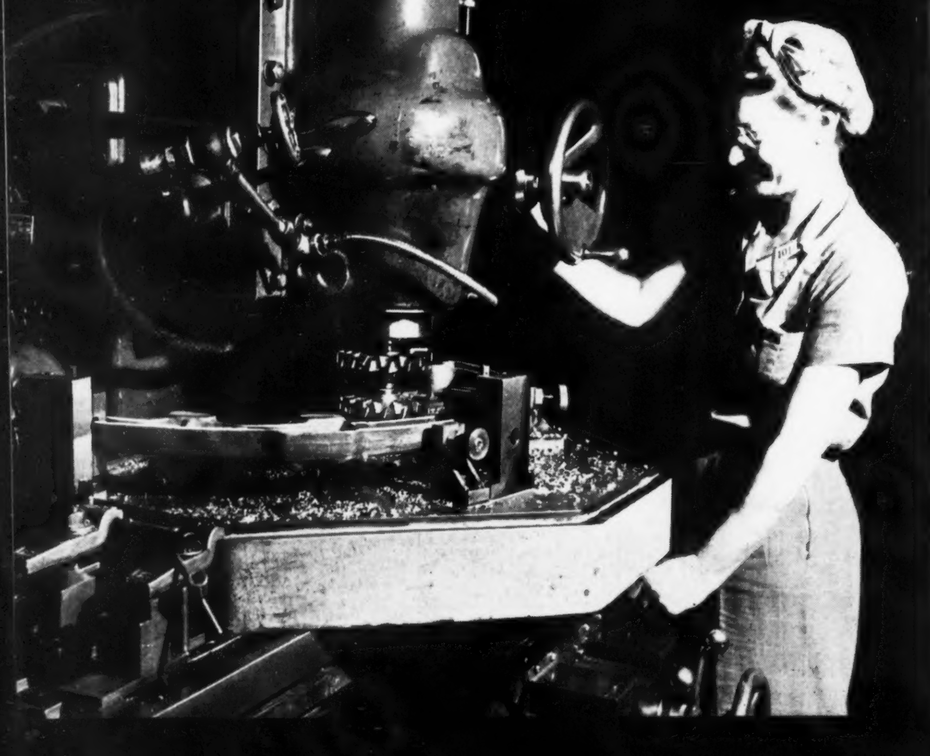


Fig. 6. Bosses of Motor Mount Rings are Simultaneously Milled on Opposite Sides by Two Cutters. Clamps Automatically Center the Work between Cutters

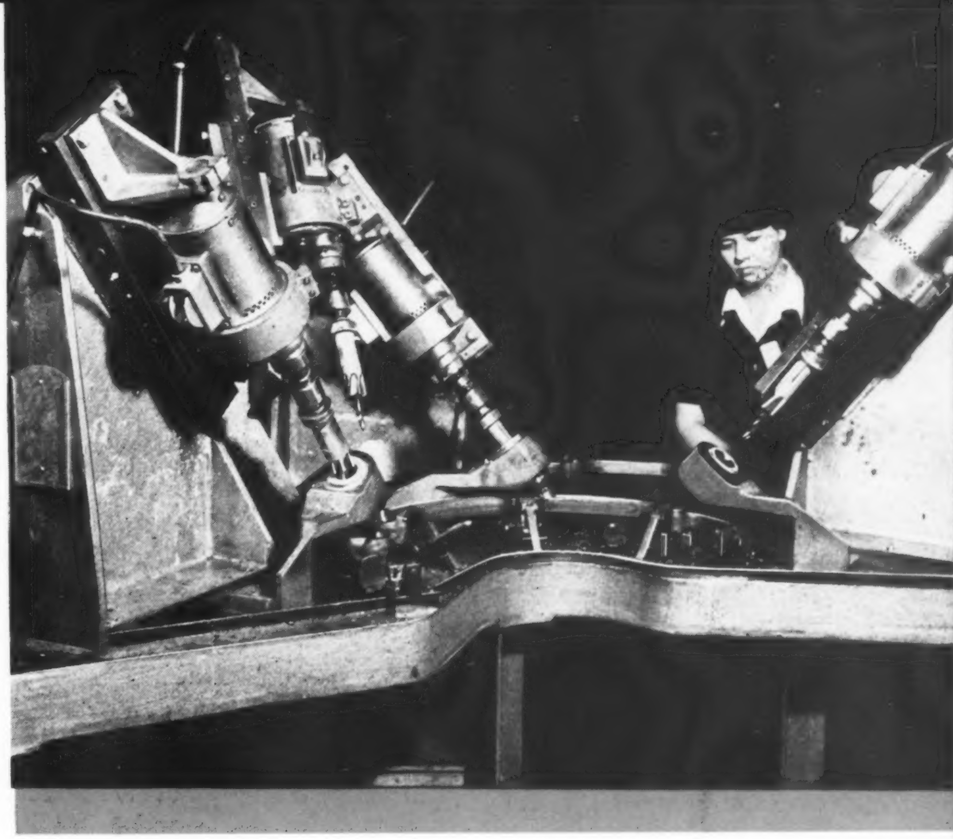


Fig. 7. Portable Electric Drills Mounted on Angular Columns Simultaneously Drill and Spotface Angular Holes in Motor Mount Rings

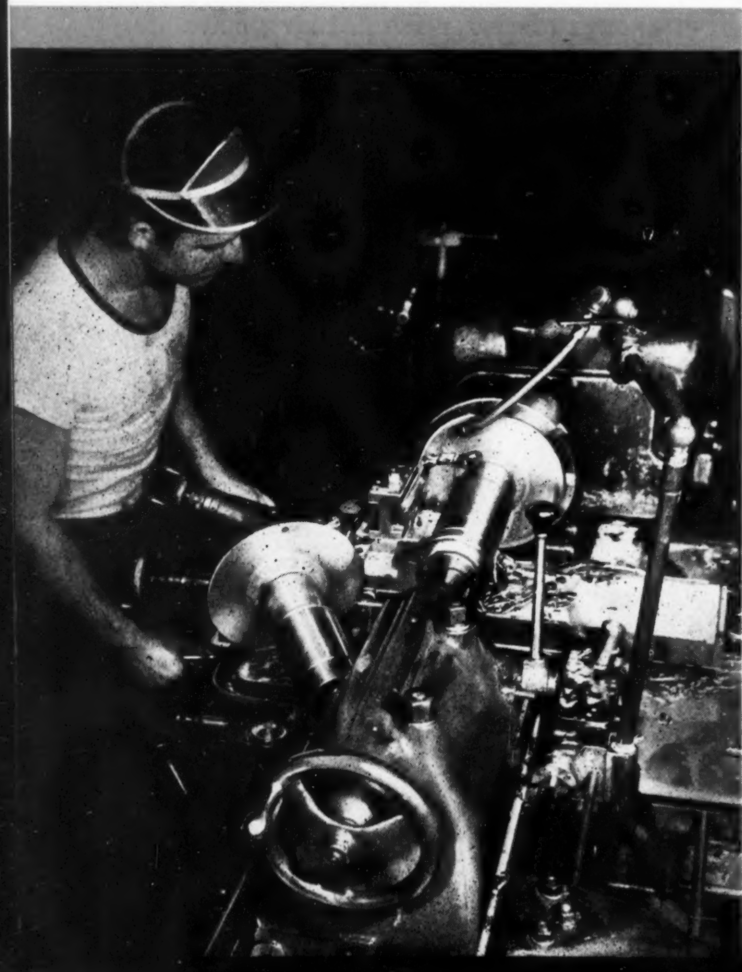
performed on a Milwaukee milling machine of the vertical-spindle type. The principal feature of this fixture lies in the construction of the clamps, which are designed with top and bottom jaws that are moved in unison toward or from each other when a wrench is applied to a right- and left-hand screw which passes through both jaws. With this arrangement, the work is automatically brought to the desired milling height by each clamp. The clamps are made to suit the I-beam section of the motor mount rings.

Previously, only one face of these bosses was milled at a time. The present method of milling both faces together and the quick clamping arrangement have effected a saving in time of at least 50 per cent over the former method. The two faces of each boss are milled to the specified thickness within plus or minus 0.005 inch. Corresponding tolerances are specified on the parallelism of the boss faces and on the relationship of the different bosses. The motor mount rings are chromium-molybdenum forgings. In loading the work fixture, the bosses are checked by means of a gage to make certain that the set-up allows enough stock for the finishing cut.

Four other bosses located in an angular posi-

Fig. 8. Landing-gear Frames that were Previously Finished on the Arms by Milling are Now Machined to the Required Dimensions on a Shaper

Fig. 9. Tapping Operation on Tail-wheel Parts, which has Practically Eliminated Rejected Work Due to the Methods of Feeding Tap and Holding Work



tion relative to those faced in the preceding operation are later drilled and spot-faced by employing the special set-up illustrated in Fig. 7. This involves the use of four portable electric drills, mounted at the required angles. The portable electric drills are assembled on slides that are fed up and down angular columns. The slides are fed by turning a star-wheel on the back of each column to revolve a pinion which engages a rack on the corresponding slide.

Both drilling and spot-facing are performed with one down feed of any of the drill heads through the use of drills that are inserted into the spot-facers and held in place by means of set-screws. The holes are drilled to a diameter of 7/16 inch, while the spot-facers are 1 1/2 and 1 3/4 inches in diameter.

Tail-wheel parts are tapped to the Class 3 fit demanded in the aircraft industry by applying the Bakewell tapping machine shown in Fig. 9. The part is gripped between V-blocks by tightening a large C-clamp, after which two flat sides on the upper end of the part are engaged by a yoke at one end of a flat bar which is held in a vise on the left-hand side of the table. The yoke prevents the part from turning during the tapping operation. This operation is now performed with practically no rejected work, whereas the threads were frequently torn in the practice previously followed.

Landing-gear frames are now being finished on opposite sides of both arms on Rockford hydraulic shapers set up as shown in Fig. 8, with a saving in time of approximately 50 per cent in comparison with the milling method previously used. The chromium-molybdenum forging is firmly gripped by five sets of clamps. The tool is set accurately for height from a round vertical bar, which is permanently mounted on the front side of the fixture.

Collar assemblies for landing gears are completely finish-turned and the flange faced on one side in the operation shown in Fig. 10, which is performed on an American Pacemaker engine

Fig. 10. Carbide-tipped Tools Finish-turn Cylindrical Surfaces and Finish-face the Wide Flange on Fabricated Landing-gear Collar Assemblies

lathe. This part is fabricated by welding a rough-turned tube to a disk of metal, 3/8 inch thick, after the disk has been bored to fit the flange. The part has been rough-bored prior to the operation illustrated. It is supported from the bore by a ball-bearing tailstock center, while the opposite end is gripped on the inside.

After this operation, the opposite side of the flange is also faced in an engine lathe. When the part has been finished, the flange is only 1/8 inch thick, and both faces must be closely parallel and also at right angles to the axis across the entire 8 inches of flange diameter.

The application of an American radial drilling machine for drilling and reaming forged fittings in the opposite ends of landing-gear struts is shown in Fig. 11. One of the holes is finished to a diameter of 0.906 inch, and the other to 1 1/8 inches. A jig insures a close center-to-center distance between the two holes.

Holes are countersunk at high speed in spar chords by the Farnham machine shown in Fig. 12, which was recently installed in one of the plane sub-assembly departments. The operator successively feeds holes that were previously drilled through the spar over a plunger on the bottom arm of the machine. On opposite sides of this plunger are two small vertical spring-backed fingers which are depressed when the spar is pushed down. The depression of these fingers actuates a solenoid switch which causes the countersinking spindle to descend for the operation and then automatically return to the starting position. The plunger moves down with the fingers, out of the way of the countersinking tool. The countersinking spindle is fed and returned at fast rates by an air cylinder. All chips are blown off the work and away from the tool by means of an air blast.

Two machines of this type are able to handle all work of this nature that goes through the shop, whereas formerly, about two dozen drilling machines were unable to keep up with production schedules.

Fig. 11. Forged Fittings in the Ends of Landing-gear Struts are Drilled Accurately as to Center Distance by Employing a Fixture Set Up on a Radial Drill

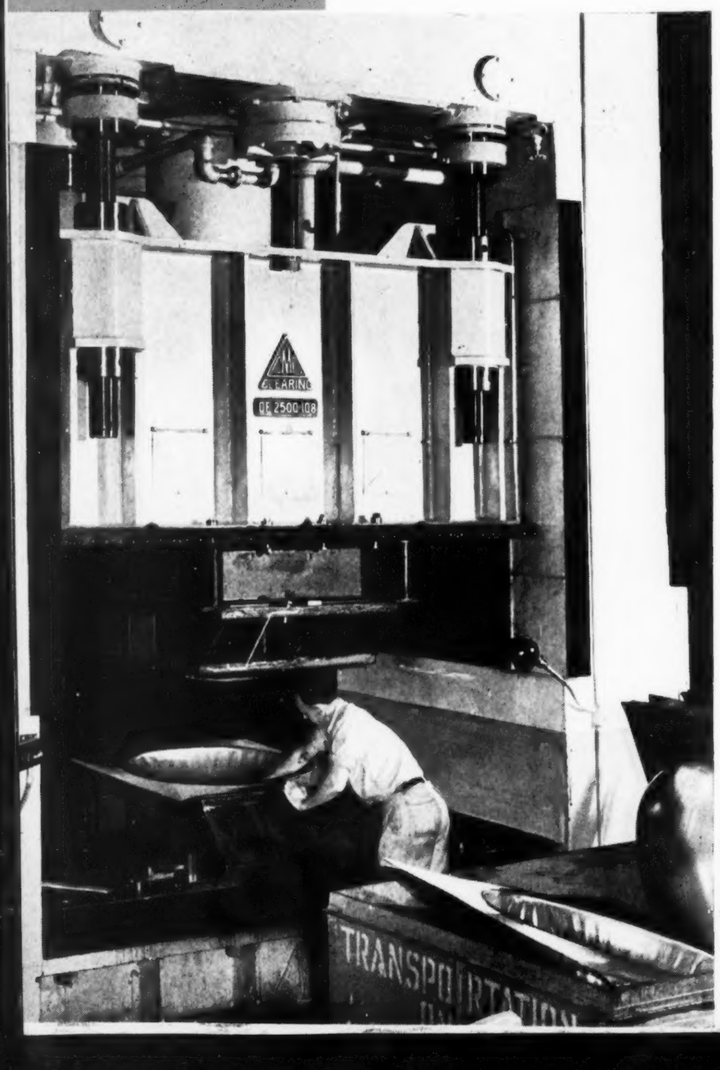
Fig. 12. Machine Recently Installed in Douglas Plane-fabricating Department for the Rapid Countersinking of Holes in Spar Chords

Deep-Drawing

Deep-Drawing Dies and Hydraulic or Mechanical Presses are Used by the Boeing Aircraft Co. for Producing Seventy Per Cent of All Formed Parts Required in Building Flying Fortresses—the Planes that Carry More Bombs Faster and Higher than Any Other Bomber in the World

By BOYD K. BUCEY, Superintendent of Tools
Boeing Aircraft Co., Seattle, Wash.

Fig. 1. A Deep-drawing Operation on Alclad Aluminum, in which a Bowl 35 Inches in Diameter is Drawn to a Depth of 14 Inches by the Use of Meehanite Dies. The Part being Drawn is the Tail-wheel Housing for a Flying Fortress



ONE of the pioneers in the wide application of deep-drawing dies for shaping the large number of formed parts required in the construction of airplanes, the Boeing Aircraft Co. has now expanded this practice until over twelve hundred such parts are being made on hydraulic and mechanical presses. Approximately seven hundred and fifty dies are kept ready for service, a considerable number of these being suitable for forming two or more parts similar in shape but of different lengths. Of these, about four hundred are truly deep-drawing dies. Rope drop-hammers formerly used for working most sheet-metal parts are now being used almost entirely for turning out experimental parts or work-pieces for new models and for making modifications on purchased parts already formed rather than for quantity production of regular work.

The extensive use of deep-drawing dies by the Boeing Aircraft Co. was instituted by H. Oliver West, executive vice-president, and in charge of manufacturing. Long before the Japanese attack on Pearl Harbor, Mr. West laid the groundwork for quantity production of Boeing Flying Fortresses. Most of the operations outlined here are the results of his planning.

The reason deep-drawing is being so widely applied in this field is that this method enables complicated pieces to be formed within the shortest time and within the close dimensional tolerances specified in airplane building. Tolerances are generally within plus or minus 1/64

HELPS TO BUILD FLYING FORTRESSES

Official U. S. Navy Photograph

inch, which is extremely close for parts produced from sheet metal, especially aluminum alloys, which have unpredictable tendencies, so far as dimensions and shapes are concerned, as a result of heat-treatment and aging.

Generally speaking, in the airplane industry a part must be produced from the specified material only. If difficulties arise in deep-drawing a part, it is not possible to change to a material having somewhat different physical characteristics that might facilitate the drawing operation, as is frequently done in the automotive and other industries in normal times. Also, the dies must be made to produce the part as it has been designed. Strength and aerodynamic requirements frequently prevent modifying the dies to aid in the deep-drawing.

Other handicaps encountered in deep-drawing aircraft parts arise from the fact that aluminum-alloy sheets vary several thousandths of an inch in thickness between the edges and the center of the sheets. This necessitates making provision for close adjustment of die members, because a die that is functioning perfectly one day may not operate satisfactorily the next day as a result of slight variations in the thickness of the stock at drawing points between the punch and die. Experience is of vital importance in the successful design and use of deep-drawing dies for aircraft parts.

The biggest problem of all is to maintain the shape of drawn parts within the required dimensional tolerances after heat-treatment. Wherever it is possible to do so, the practice is to heat-treat the material and keep it in refrigerators until it goes to the draw presses. When it is necessary to draw the metal in the soft condition, the practice is to draw to within about

DEEP-DRAWING

Fig. 2. Second Operation which Forms Beads in the Tail-wheel Housings that were Drawn in the Operation Shown in Fig. 1

Fig. 3. Another Set of Meehanite Cast-iron Dies, which is Used to Form Stainless-steel Sheets to an Unusual Shape, as Shown by the Sample being Held at Back of Press

1/4 inch of the final depth, then heat-treat the part, and finally redraw it to the required depth. With this method, the work-pieces will usually stay in the condition in which they leave the redrawing dies.

Dies for airplane production must also be of a more versatile design than those used in automobile plants before the war, because production demands are not even now sufficient to require their constant use. They must, therefore, be frequently dismantled and replaced on presses, and as it is virtually impossible to assign the dies always to the same machines, they must be made applicable to various presses in the shop.

In spite of these problems, deep-drawing is of inestimable value in the production of aircraft parts. Complicated work can be drawn in two or three minutes and with one operation of a press that might require a large number of blows under a rope drop-hammer and much hand work between the successive blows in order to prevent the formation of wrinkles.

Work uniformity, too, is insured by deep-drawing, whereas parts produced under rope drop-hammers may vary widely, especially in these days when skilled workmen are scarce. Aircraft parts should fit sub-assembly jigs without any hand fitting, and consequently, uniform-

HELPS TO BUILD FLYING FORTRESSES

ity is of utmost importance. Accurate parts save assembly time, which constitutes 60 per cent of the time consumed in building airplanes.

Cleanliness of presses and dies is very important, since scratches or other marks on airplane parts will result in rejected work. Boeing presses are kept clean all over, not merely around the bolster and ram. The stock delivered to the machines must also be clean of all dirt, emery, or metal chips.

The majority of the punches and dies used for deep-drawing in the Boeing plant are made of Kirksite, although some are constructed of Meehanite cast iron. In Fig. 1 is shown a Meehanite cast-iron die set being used on a Clearing 500-ton press for the first operation on tail-wheel housings. The ram is fitted with a blank-holder around the punch, which grips the flat sheet of 24SO aluminum on the top of the die during the first action of the ram, and holds it securely when the punch is brought down by the second action. A bead is formed around the blank by the blank-holder and die to increase the gripping force. This die set draws a bowl about 35 inches in diameter to a depth of approximately 14 inches.

After the housings have been heat-treated and one end sheared off, they go through a second

Fig. 4. Forming Large Half-rings for the Fixed Cowling Nose with a Die Set that Includes a Circular Backing-up Ring in the Die

Fig. 5. Kirksite Punch and Die which Turn out One-piece Door Frames in One Operation of the Press to Replace Frames that were Previously Made from Thirty-five Stampings

operation in the same press. For this operation the press is equipped with the set of restriking dies shown in Fig. 2. This die brings the part to final size and also forms a series of radial stiffener beads as the metal is forced between ridges on the punch and corresponding depressions in the die surfaces. A large bead that extends the full length of the part is also formed by a ridge on the punch, which pushes the metal into an opening or slot in the die. This lengthwise bead is cut off in a later operation when the part is severed into halves.

Another interesting die constructed of Meehanite cast iron is illustrated in Fig. 3. This die draws a piece of the fixed cowling from 0.019-inch thick 18-8 stainless steel to a depth of about 10 inches. The finished part is approximately 28 inches long by 16 inches in maximum width. The illustration shows a flat blank lying on the die. In this case, the blank is somewhat shorter than the die opening, as the die is suitable for drawing work of different lengths.

Again, the blank is gripped between a blank-holder on the ram and the top of the die during the first downward action of the ram, and a bead is formed in the blank to increase the holding effort and retard the flow of metal. This principle is applied particularly in drawing operations on stainless steel. The part is drawn as the punch continues its descent.

This die is equipped with a movable member inside the outer block, which is supported by pins that extend upward from a hydro pneumatic cushion in the bed of the press. The movable die member aids in the formation of the part by holding the blank firmly against the bottom of the descending punch, and also ejects the work at the end of the operation.

This piece of work is turned out in one operation of the press at the rate of three pieces a minute, whereas at least thirty-five minutes would be consumed in producing the part under a rope drop-hammer. The drawing operation is facilitated by wiping a drawing lubricant over the sections of the blank where most of the drawing takes place, so as to aid the slippage of the material between the drawing edges of the punch and die.

Three stiffener beads are formed on each side of this stainless-steel part in a second press operation, and later, the stamping is cut in two.

Another punch and die constructed of Meehanite cast iron for drawing 18-8 stainless steel is shown in Fig. 4. This part is a fixed cowling nose, and it is produced on an HPM 500-ton double-acting hydraulic press. Only half of the circular die is used, because it has not been possible to obtain large enough blanks of material for forming complete rings. The die, however, was designed in anticipation of that possibility. A shim of stainless steel is kept on the unused side of the die to equalize the pressure on both sides of the blank-holder and thus insure satisfactory gripping of the blank.

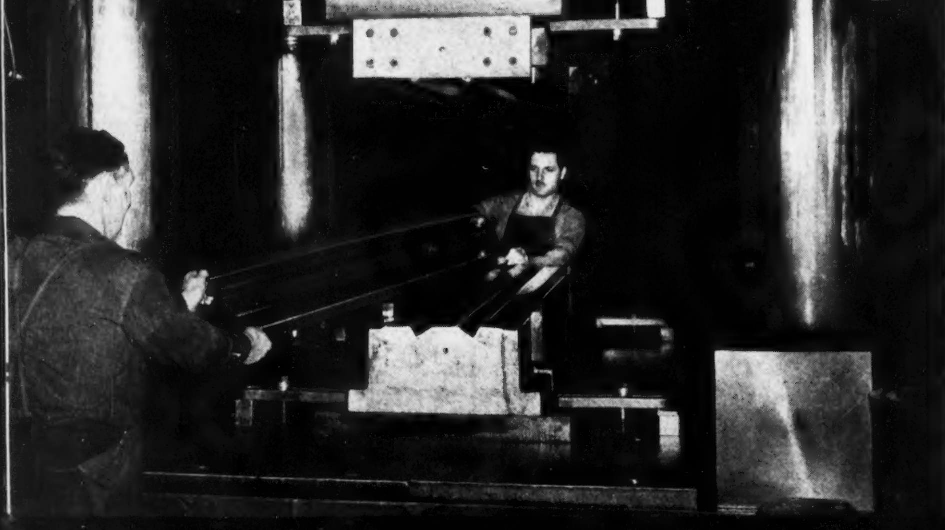


Fig. 6. Long Kirksite Punch and Die which Form Contoured V-grooves in Aluminum Strips to be Used as Flooring Angles on Flying Fortresses

The blanks are sheared from square sheets of stainless steel by means of portable electric shears. Lubricant is painted over the blank just before it is placed on the die. In this operation, a bead is also formed between the blank-holder and the die to obtain maximum gripping action. When the punch descends, the portion of the sheet that is being formed and a backing-up circular ring within the die descend together until the part has been drawn to the required shape. The movable die ring is made with a series of slots which permit curved pieces in the stationary base of the die to be exposed when the die ring has been depressed all the way. These curved inserts form radial ribs in the cowling nose, as shown.

A bomb door for a bombardier's compartment is drawn in one piece from Alclad aluminum by the dies illustrated in Fig. 5, which are shown set up on a Clearing 350-ton double-action mechanical press. Four depressions, about 12 inches in diameter by 1 1/2 inches deep, are formed in the sheet at one operation. This die is constructed completely of Kirksite.

Again, the ram is fitted with a blank-holder, and there is a central movable die piece, or pressure pad, which is supported by a pneumatic cushion in the press bed. Bombardier door frames were formerly made up of about thirty-five separate pieces that had to be riveted and spot-welded together in a large number of operations. The operation shown, compared with the previous procedure, emphasizes the economies that can be effected through deep-drawing.

Heavy punch and die members of Kirksite are seen on the Lake Erie 2500-ton hydraulic press illustrated in Fig. 6. The operation consists of forming two contoured V-grooves in strips of 24SO aluminum alloy about 7 feet long. The stock is heat-treated prior to this operation, and is formed before aging occurs. As a result of this practice, the operation is performed without wrinkles developing. These aluminum-alloy strips are used as flooring angles on Boeing Flying Fortresses.

An ingenious die set designed for use on a Bliss 255-ton mechanical press for producing air scoops from 24SO aluminum is shown in Fig. 7. Blanks cut out to the shape of a keystone, as seen at the right of the die, are slipped, one at a time, under plates on opposite sides of the die. These plates exert a pressure on the blank at the beginning of the operation. The die is fitted with a pressure pad, actuated by an air cushion in the bed of the press, which holds the blank against the face of the descending punch. The part is formed between stationary die-blocks, being gradually drawn from under the gripping plates until it assumes the shape indicated by the example at left of the die.

At the end of this operation, the air-operated pressure pad lifts the piece clear of the die. At the same time, pins raise the gripping plates slightly for convenient reloading.

Fig. 7. Die Set of Unusual Design Installed on a Mechanical Press for Forming Air Scoops to Shape Shown by Example at the Left of the Die

The Martin

VETERAN OF THE

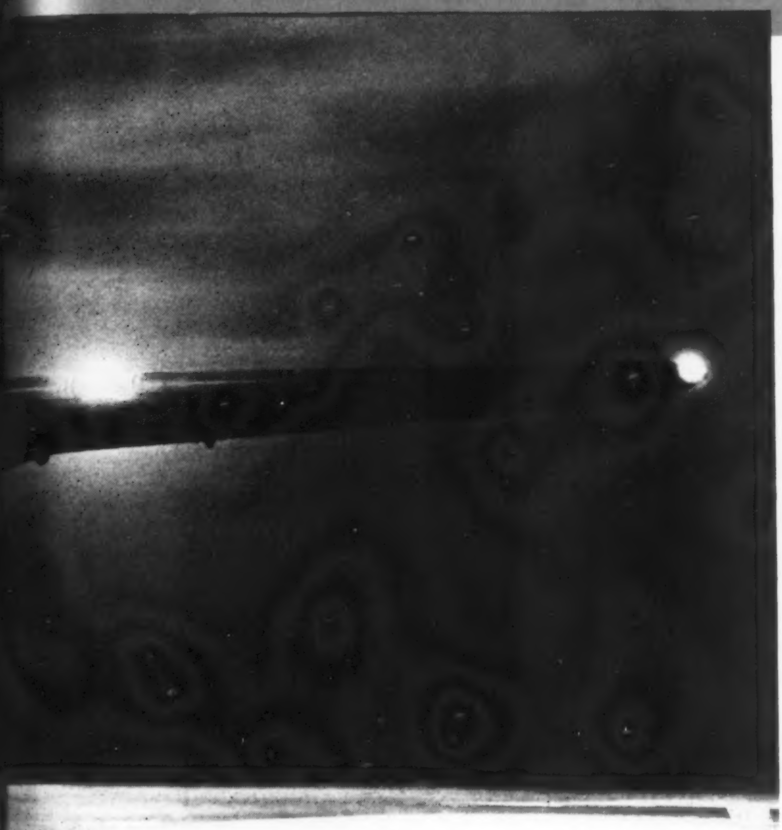
THE Glenn L. Martin Co. is one of the oldest companies in the aircraft manufacturing industry. Years ago it built the first American bombing plane. Recently the world's largest flying boat, the Mars, came from its work-shops. Today, its medium B-26 bomber, called the Marauder, is acknowledged to be one of the best in its class. Developed early in 1939, it was the first military plane to be placed in production without going through a two- or three-year design-to-product period.

Because of its relatively long period of manufacture, as war planes go, there has been much opportunity for improvement in methods of manufacture. In fact, a staff of methods improvement engineers is continuously studying operation after operation in the manufacture of the B-26 bomber, seeking ways to effect savings in time and labor. Not all of the ideas for better ways of doing the job come from the methods engineers, of course. Many come from the workers themselves.

An important factor in obtaining increased production in fabricating B-26 parts has been the development of special jigs for use on Erco punching and riveting machines. One of these machines is shown in operation in Fig. 1. It has a dual function. An air cylinder actuates a driving plunger, which, on its first stroke, carries the punching die to the work and punches the holes. On its second stroke it inserts the rivet into the hole and heads it. A stripper die supports the assembly being riveted, and is used to locate rivets from holes in the Erco jig.

Marauder

WORLD'S BATTLEFRONTS



This Bombing Plane has been in Continuous Production for Over Two Years. At the Martin Plant, Methods of Building It are being Constantly Improved by Engineers Who Seek to Save Precious Time and Labor

By
HOLBROOK L. HORTON

Assemblies consisting of flat sheets, formed parts, channels, angular and "Z" sections, extrusions, reinforcements, and clips can be quickly riveted together with the aid of these specially designed jigs. One of the advantages afforded by these jigs is that by incorporating indexing holes in them the use of pilot holes, prick-punch marks, spray templet markings, or a spotlight to locate the exact position for punching has been eliminated.

In many cases, the parts to be assembled can be nested together in a simple jig. It is possible for the operator to hold these parts in place with his hands while holding the jig at the same time, due to one of the outstanding differences between these jigs and the usual type of drill jig.

Ordinarily, if several parts are inserted in a drill jig, they must be held firmly in place throughout the entire drilling operation, so that all the holes will line up when the parts are reassembled. With the Erco jig, however, this is not necessary, because each rivet is driven immediately after the hole is punched, leaving no chance for the shifting of a part. In fact, the rigidity of the entire assembly in the jig increases as the operation progresses. The use of these jigs has made it possible to assemble and rivet many work-pieces in 10 to 20 per cent of the time formerly required.

In the manufacture of the B-26 bomber, every effort has been made to utilize to the best advantage the equipment at hand, and where possible, to make use of standard machines by

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Fig. 1. Use of Dual-operation Punching and Riveting Machines with Specially Designed Jigs has Increased Sub-assembly Production Many Times Over

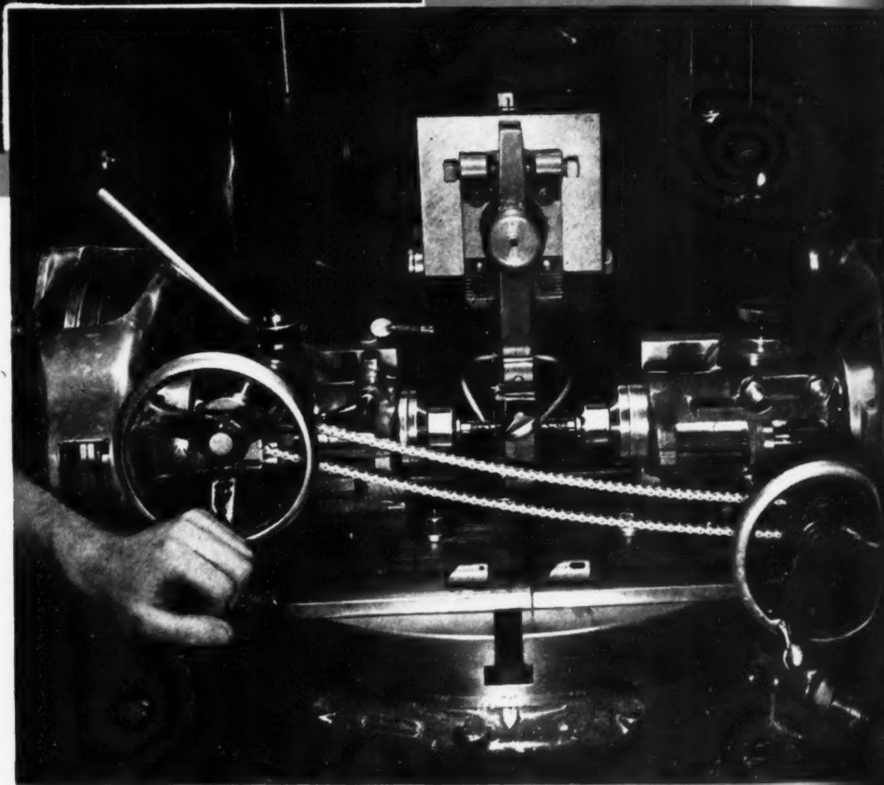

Fig. 2. Ingenious Use of Two Milling Heads on Slotting Machine for Elongating a Hole in Small Steel Cams to Produce a Slot. Unfinished Piece is Shown at Left, and Finished Piece at Right

adapting them to perform special jobs. As a result, many machines are being successfully utilized for operations that are quite different from those for which they were designed.

Two Bridgeport milling heads mounted on the rotary table of a Pratt & Whitney slotting machine, as shown in Fig. 2, are used for elongating a hole in each side of a small steel cam into a slot. A chain drive synchronizes the feed of both heads, so that the operator need only turn one handwheel. The work is held in what ordinarily would be the tool-head and is traversed across the milling cutters to produce the slot. A variety of slot-elongation jobs can be handled by this set-up.

An automatic fixture that utilizes a dividing head on a shaper is shown in Fig. 4. A special indexing arrangement rotates the work-piece after each cut. The operation consists of cutting serrations in the end of door shafts. The dividing head was utilized because it was the most convenient means of providing a center for holding the work and a satisfactory point of attachment for the indexing device.

Another interesting fixture is used for a straddle-facing operation on pulley brackets,

as shown in Fig. 3. Several different pulley brackets are faced in this fixture, and each has arms that are at different angles with the base. The fixture is held in the proper position by means of a pneumatically operated clamp, while pin-stops locate the base at five different angles, as indicated by the scribed lines and piece part numbers along the edge. A Cincinnati horizontal milling machine is used for the operation.

Continuous straddle-milling of fittings for brace-tube engine-bearer supports is accomplished on a Cincinnati vertical miller with the aid of the fixture shown in Fig. 5. As the lugs are rotated past the milling cutters a facing cut is taken on each side and a depth cut in the center of the slot. The pieces are clamped in the fixture in holding blocks which can be quickly unclamped by the operator as he loads and unloads the work. The machine operates at 41 R.P.M., with a feed of 1 1/8 inches per

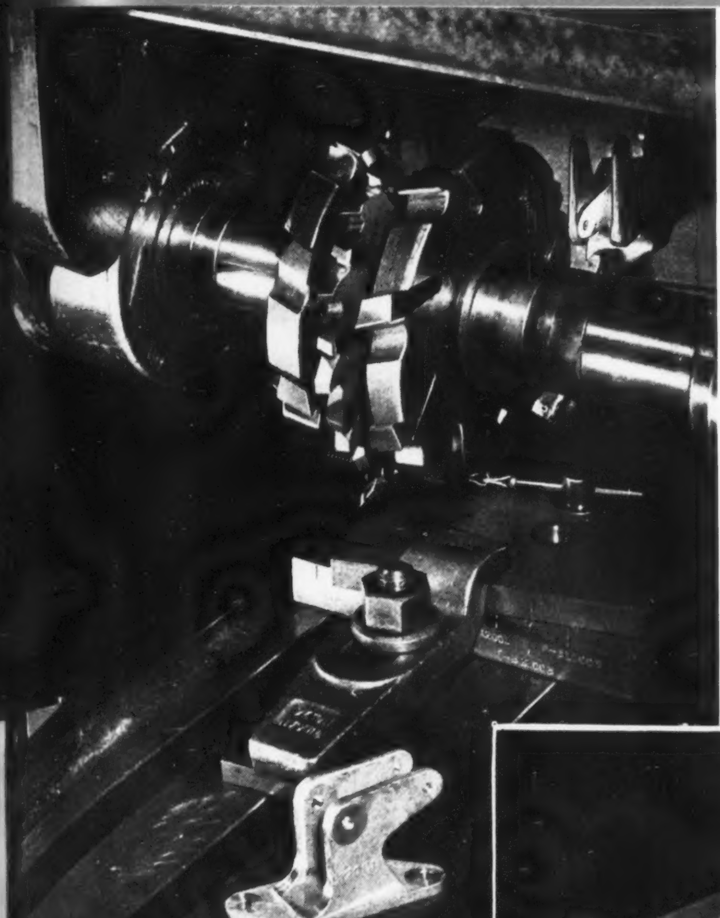

Fig. 3. (Left) Arrangement for Straddle-milling Bosses on a Pulley Bracket. Scribed Lines and Piece Part Numbers along Fixture Base Indicate Angular Settings for Different Brackets

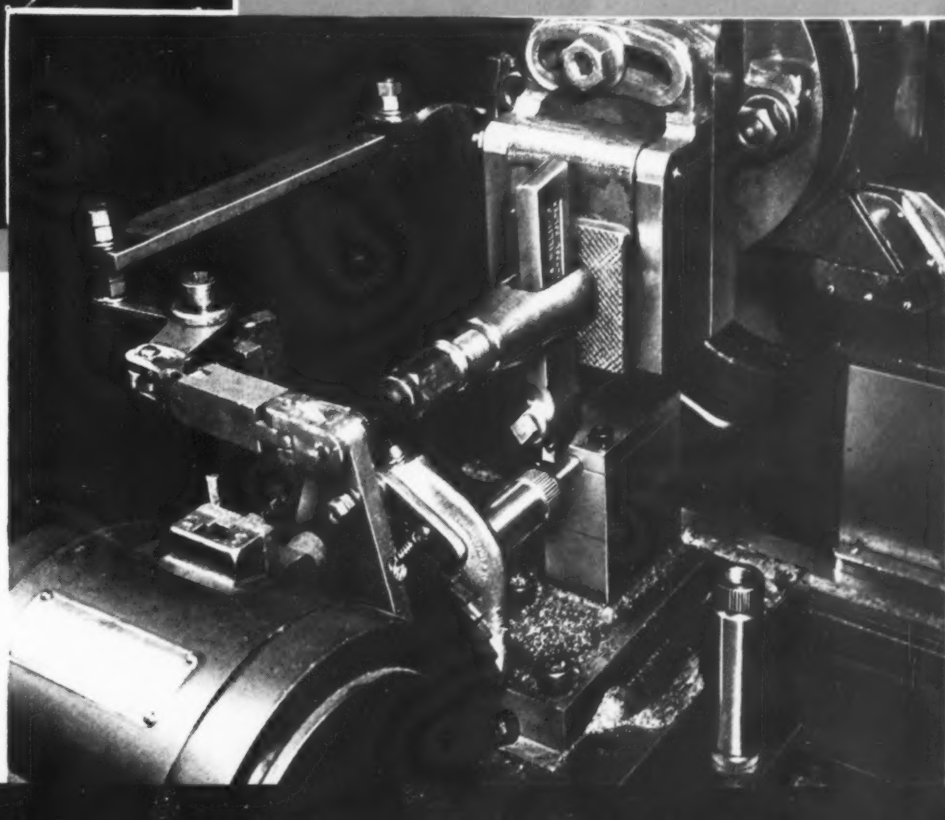

Fig. 4. (Below) Adapting a Shaper for Cutting Serrations in End of Door Shaft. An Automatic Indexing Device is Mounted on Dividing Head which Provides Work-holding Center

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Fig. 5. A Continuous Straddle-milling Operation on Brace-tube Engine-bearer Supports. Operator Loads and Unloads Machine as Fixture Carries the Work past the Cutters

minute. The pieces are S A E X4130 steel forgings.

One of the most interesting forming operations in the manufacture of B-26 parts is that shown in Fig. 6. Here a plate of 24-SO aluminum, 3/8-inch thick, is being shaped to the required curvature on a drop-hammer. After forming, the plate is heat-treated to a high hardness. This is the second of two drop-hammer operations, and is performed on a Chambersburg Cecostamp, using Kirksite dies.

Considerable success has been experienced with the use of Kirksite dies, particularly as regards the length of runs before these dies need to be trimmed or sharpened. It is thought that part of this success is due to a special design of furnace used to melt the Kirksite. This is a Martin patent and development, and the R-S Products Corporation of Philadelphia is the licensee. The feature of this furnace is a 4-inch jacket of lead, which separates the parts from the gas flame. The use of this thick lead jacket has prevented the combining of iron in the pot with zinc in the Kirksite alloy by eliminating the hot spots formerly caused by the gas flames impinging directly on the part. The gas burners are Micromax-controlled, and the temperature of the alloy is maintained at 820 degrees F.

Fig. 6. Forming Heavy Aluminum-alloy Plate to Required Curvature on Drop-hammer. Finished Part is at Left, Flat Plate at Right

Vega's Experience with Carbide Milling Cutters

(Continued from page 159)

cutting edge and along the clearance land, it should be immediately taken out of operation and "touched up" with a fine diamond wheel.

The full advantages of carbide-tipped milling cutters cannot be realized until milling machines are designed especially for their use. Few of the universal, horizontal, or vertical production type milling machines built today have sufficient horsepower to pull cutters of this type through heavy cuts at the speeds and feeds desired. For hyper-milling cutters, the milling machine should have an increase in horsepower of at least 50 per cent over present machines.

Rigidity is another important factor in using this type of cutter. Since little vibration occurs in the cutters and arbor when the arbor support is reasonably close to the cutters and the overarm is securely locked, machines that have the spindle and driving mechanism movable vertically are best suited to the use of carbide-tipped cutters. However, in most machines at present, 50 per cent of the table is without support when the table is extended its full length of travel. This lack of support puts a strain on the knee, saddle, cross-slide, table, gibs, and ways, and promotes vibration when high speeds and feeds are used.

It has been Vega experience that excessive vibration of the table, saddle, or knee mechanism is responsible for most failures of carbide-tipped cutters. This is because vibration of the table and its supporting structure will not only cause the tip of the cutter, which has less clearance than high-speed steel cutters, to drag on the work, but will also permit rapid impact of the cutter against the material and foster breakage of the tip. This condition could be eliminated if milling machines were redesigned so that the table was supported for at least 90 per cent of its full travel. Another distinct advance in machine design would be to provide double sets of gibs and ways for both saddle and table.

In spite of the lack of properly designed milling machines, carbide-tipped cutters have done a magnificent job in the Vega shops, and the future production possibilities afforded industry by this revolutionary machining method are tremendous. Vega has 600 of these cutters now in service, and by the end of 1943 there will be between 1500 and 1800 of these cutters in use.

Results Obtained by Pontiac with Chromium-Plated Tools

THE life of many cutting tools used in war production has been greatly increased by chromium plating, according to information obtained from the Pontiac Motor Division of General Motors, where chromium plating of cutting tools has been studied for nearly ten years. The experimental work was accelerated by the scarcity of high-speed tools at the beginning of the war and by the short life of these tools when used on the high-alloy steels specified for various types of war material. It is now stated that the experiments conducted by Z. T. Crittenden, chief metallurgist at the Pontiac plant, have proved so successful that the majority of the cutting tools now used in this plant on war work are being chromium-plated as soon as they arrive from the tool manufacturer.

The cutting tools are plated in 400-gallon tanks. Prior to plating, the tools should be thoroughly cleaned, and care should be taken to see that the tools are at the bath temperature before starting the plating process. This is accomplished by hanging them for twenty seconds on the reverse bus-bar. The tools are then placed on the cathode bar, and given a maximum flash of from 20 to 30 amperes per square inch. This current is maintained for approximately fifteen seconds and tapered off to about one-half the maximum current density at the end of thirty seconds. The tools are plated another thirty seconds at this rate and then removed.

Some of the results obtained by flash chromium-plating tools are quoted in the following: Core drills have shown a 56 per cent longer life. Reamers on small Diesel-engine parts that average 70 pieces before chromium plating now average 110 pieces. Tool bits that averaged 23 connecting-rods now are good for 56 rods. On tank axles, chromium-plated bits average 110 pieces, as against 67 pieces for the unplated bits. The life of taps in some instances has been increased from 160 holes to 210 holes, and in another instance, from 300 holes for a new tap to 1000 holes for a reclaimed, chromium-plated tap.

The Pontiac experiments, however, indicate that chromium plating is of little or no value on tools working on ordinary grades of steel; it is when high-alloy steels are machined that the savings become apparent.

Editorial Comment

Great as is the production of war materials in American factories, we have not yet reached the peak. There is no chance of resting on our oars. The output must reach a much higher level than that obtained so far.

Here and there it has been said that the current requirements of the armed forces are practically being met. Nothing could be further from the facts. During the first three months of the year, American industry produced 19 per cent of the 1943 quota; during the second quarter, production reached approximately 22 per cent, making a total of slightly better than 40 per cent for the first half of the year.

Next Six Months' War Production Must Show 50 Per Cent Increase

This means that about 60 per cent of the year's output must be produced during the last six months of the year; in other words, during the next six months we must produce 50 per cent more than we produced during the first six months; and the schedules for 1944 call for still greater effort—for a production higher than that of 1943. Obviously, there can be no slowing down in production.

True, there has been some shifting in the production effort. For example, some plants building tanks have been requested to reduce their output. But why? Because the manufacturing skill and capacity of those plants are more urgently needed for building other things necessary to the successful waging of war, such as locomotives, railroad cars, and artillery.

A change in the production schedule does not mean less production. On the contrary, it is extremely important that every American manufacturer and worker should realize that the present production of industry is not adequate to meet the requirements. There have been some cancellations, but these are more than offset by greater demands for other types of war equipment. For example, the production of small bombs may have decreased, but that of block-busters has greatly increased. Such changes must be expected. But even these changes are trivial in the whole picture of war production, and do not affect over 2 per cent of the total.

When it is said that industry must produce 50 per cent more in the next six months than was produced during the first six months of the year, this does not mean that industry fell down on the job. It simply means that many new manufacturing facilities have just been completed, so that greater output will be possible from month to month.

Take the aircraft industry, for example. While in numbers of planes the 1943 output may not seem as much greater than that of 1942 as might be expected, when the weight and size of this year's planes are considered, it will be found that the output will be approximately three times as great. In shipbuilding, the tonnage completed will increase month by month.

In the machine tool industry, the pressure is being considerably reduced in certain instances, but there is still a tremendous backlog to be filled. As a whole, it would take the industry five months to produce the machines now on order. Approximately 100,000 machine tools are still to be delivered, valued at $600,000,000. To be sure, there are cancellations; but so far, for the industry as a whole, the new orders more than offset the cancellations, even though they are not equal to shipments.

There Must be No Let-up in the War Production Effort

Deliveries are needed at the earliest possible date. Many of the war manufacturing projects are not yet completed; and with changes in production requirements, there will be still more machine tools needed. Where individual plants may not be able to devote their entire capacity to machine tools, the machine tool builder is particularly well fitted to handle either prime contracts or sub-contracts on direct war work. Aircraft engine parts, Diesel engine parts, gears, turbines for ships, valves, etc., are already among the products that are either being made or will soon be made by machine tool builders. As long as the war is going on—and, unfortunately, it is likely to go on for a long time—the labor and equipment in machine tool plants are not likely to be permitted to be idle.

The Army, the Navy, and the Air Force should never need to worry as to whether they have enough to spend in munitions and equipment to win an objective. Hence, 50 per cent more war production in the latter half of 1943, compared with the first half, is the goal.

Heating Gears for Hardening by High-Frequency Induction

Outline of a Newly Developed Hardening Procedure—From a Paper Read before the American Gear Manufacturers Association

By FRANK W. CURTIS
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Fig. 1. A 6-inch Gear with a Bushing Assembled in the Hole before Induction Heating and Hardening Takes Place

HIGH-FREQUENCY induction heating for hardening gears, while not altogether new, has made rapid advances during the past year. Unquestionably, this method of hardening will find a broad field of application within the near future. Even though induction heating is restricted to certain types and sizes of gears, the process, where applied, permits exceptionally fast heating, comparatively low operating cost, and uniform results.

High-frequency induction hardening is likely to have some effect on the types of steels to be used in the future. Heretofore, there has been a broad use of alloy steels, more often as a means of obtaining a specified hardness. However, the indications are that a regular carbon steel can be used successfully for a wide variety of gears; and when only hardness to resist wear is desired, it is quite possible that the use of alloy steels can be materially reduced. For example, SAE 1045 steel is suitable for induction-hardened gears, and surface hardnesses up to 60 Rockwell C can be readily obtained. Another grade of steel that has proved suitable for induction hardening is X-1340 (the new SAE 1141). This steel has free machining qualities and has been used successfully in the manufacture of a wide variety of gears. Other steels are available, which, having a minimum yield point of 100,000 pounds per square inch and a carbon content of from 0.45 to 0.50 per cent, will prove suitable substitutes for many of the alloy steels in use today.

Fig. 2. Illustration Showing Heat Penetration and Depth of Hardening of Gear Teeth of Different Sizes

Induction hardening will also produce some changes in the processing of gears. In the first place, a steel with a higher carbon content usually can be substituted for a carburizing steel, so that carburizing can be eliminated. A steel

with from 0.40 to 0.50 carbon is but slightly more expensive than the same type of steel with a low carbon content. Therefore, if surface hardening of the teeth can be accomplished without carburizing, a worthwhile saving results. The average cost of carburizing is $0.05 per pound, whereas the cost of a steel with higher carbon content is only $0.003 per pound.

When there is a choice between oil-hardening and water-hardening steels, it is much better to use the latter, because of the more favorable quenching conditions. With high-frequency induction heating, the hardening cycle can be automatically controlled, so that with the use of a fixture and a quench ring, a gear can be heated and quenched at one setting. This is possible also with some types of gears requiring oil-quenching, in which case an oil reservoir, pump, oil cooler, and solenoid valve are required. In other cases of oil-quenching, it is necessary to heat the work and then drop it into an oil bath.

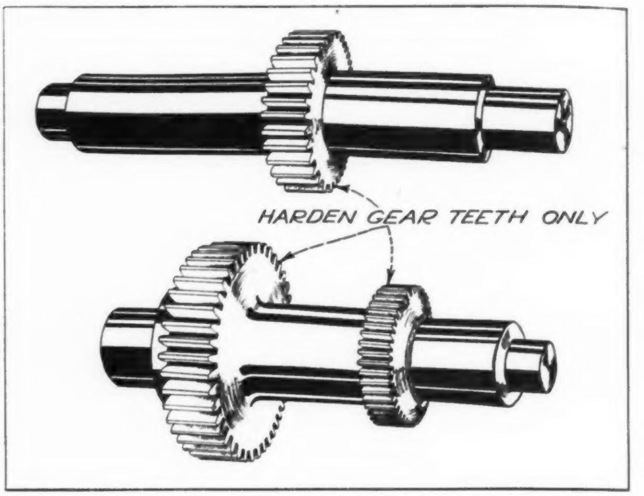


Fig. 4. With Induction Heating of Gears for Hardening, the Gear Teeth Only are Hardened, the Shafts being Left in Their Unhardened Condition

When gears are hardened by high-frequency induction heat, the method will vary somewhat according to the size of the tooth. With gears having small teeth, of about 20 pitch, the entire tooth is heated, as shown in Fig. 2 at the left. With a slightly larger tooth, of about 12 pitch, the heat pattern begins to follow the contour of the tooth, as shown in the enlarged view. On gears having teeth of 8 or 10 pitch, the heat pattern very decidedly follows the contour of the teeth, and a uniform casehardening is obtained. When the tooth is larger, such as the 4-pitch contour shown at the right, it becomes difficult to "throw" the heat down to the bottom of the tooth, with the result that the upper portion becomes deeply heated, and the heat pattern then resembles that of fine teeth. From this, it will be seen that the ideal condition prevails with teeth of 8 or 10 pitch, but a favorable condition also prevails with teeth of 12 or 14 pitch.

An advantage gained through the application of high-frequency hardening is the possibility of shaving the teeth before hardening. Usually, shaving is applied to heat-treated gears having a hardness of 32-38 Rockwell C, with no subsequent heat-treatment after shaving. With the induction-hardening method, however, it is possible to shave the gears when soft, and then harden the teeth as a final operation. This procedure has many advantages, outstanding among which are a much harder tooth and far less wear on the shaving cutters.

Another saving made possible by high-frequency induction hardening is the elimination of cleaning after hardening. Usually, a scale is formed when gears are hardened, so that a cleaning operation is required. With induction hardening, however, practically no scale is formed—no more than a discoloration of the surface—with the result that cleaning is eliminated.

As a comparison of the time required for hardening standard types of spur gears by high-frequency induction-heating converters, operating at about 300 kilocycles and with an input power of about 35 kilowatts, the gear shown at *A* in Fig. 3 can be heated in about 8 seconds, and the quench will require 5 seconds. The gear at *B* will require a heating cycle of from 12 to 14 seconds, followed by a quench of about 7 seconds. For the gear shown at *C*, the

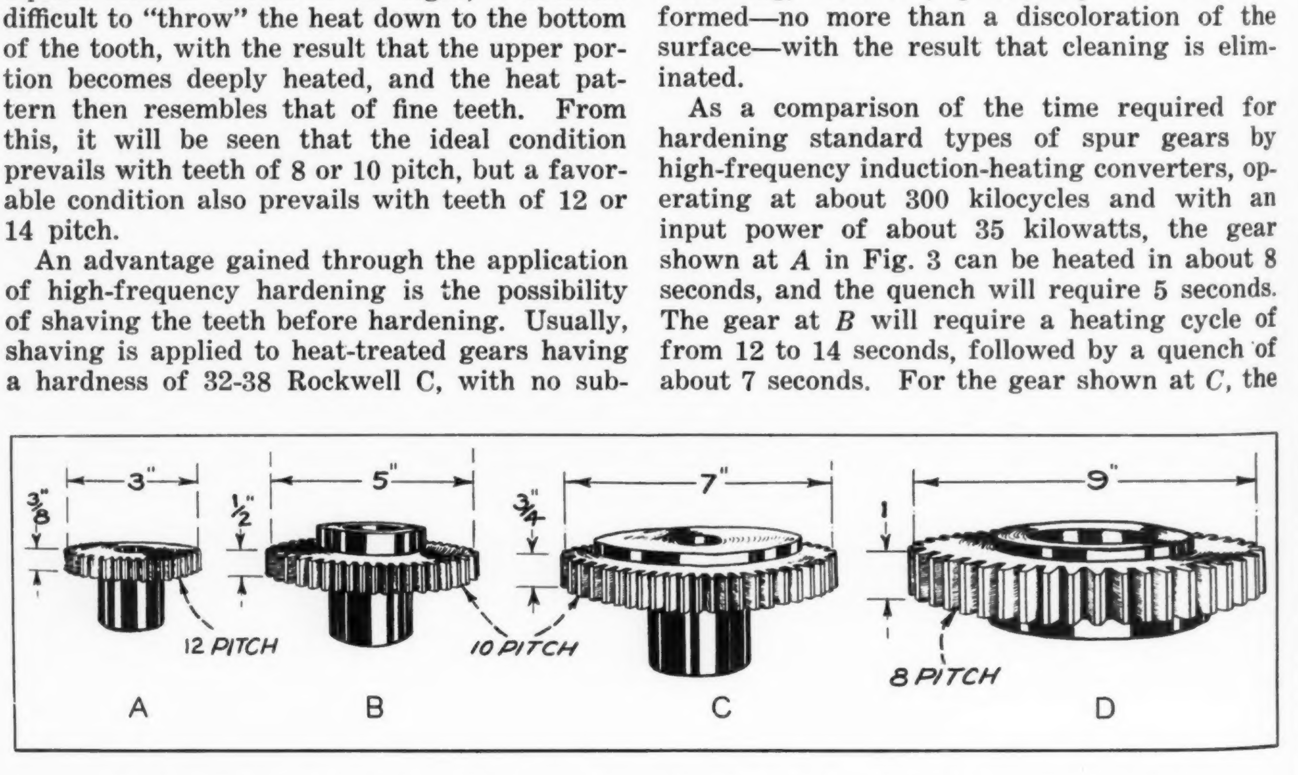


Fig. 3. The Time Required for Heating and Quenching Each of these Gears is Given in the Article

heating time will be from 20 to 25 seconds, followed by a quench of from 10 to 12 seconds. For the largest gear, shown at *D*, the heating time will be approximately 1 minute, followed by a quench of approximately 20 seconds. All these estimates are based on the use of a 0.40 to 0.50 carbon steel of the water-hardening type.

Another process change which has many advantages is the assembly of bushings and inserts prior to hardening. If a gear is to be provided with a bronze sleeve bushing, this can well be assembled before the teeth are cut. In the hardening operation, the heat will not travel as far as the bushing. In former practice, it was often necessary to locate the gear from the pitch circle and grind the hole concentric with the pitch diameter, after which the bushing would be inserted. An example of a 6-inch diameter gear with a bushing assembled in the hole before the induction-hardening operation is illustrated in Fig. 1. The teeth of this gear are cut after the bushing has been assembled, which assures concentricity.

One of the outstanding advantages of high-frequency heating for the hardening of gears is the ability to heat only the surfaces that require hardening. Two representative examples are illustrated in Fig. 4. The upper gear is cut integral with a shaft which, in turn, is mounted on a ball bearing. Since there is no advantage in hardening the entire part, it is possible, with induction heat, to harden the teeth only.

The lower example is a double-cluster gear of the same type, made in one piece. In processing this part, each gear is hardened separately, so that two operations are required for hardening.

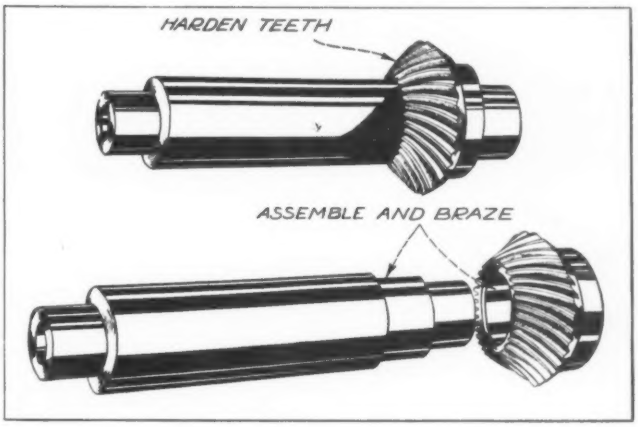


Fig. 6. A Gear Assembly that is Conveniently Handled by the High-frequency Induction Heating Method

It would be possible to harden both gears simultaneously by making a double type induction coil, but the problems involved in spacing the coil with relation to the work, as well as in compensating for the differential in the diameter of the gears, might cause complications.

After all, the hardening operation is handled so rapidly that very little time would be gained by trying to combine the two operations. The small gear, which is 2 1/2 inches in diameter, is heated in 7 seconds, with a quench of 4 seconds, whereas the larger gear, which is 4 inches in diameter, is heated in 13 seconds and quenched in 7 seconds. From this, it will be seen that the total hardening time, aside from loading, is 31 seconds per piece. If both gears were combined in one heating cycle, the total time would require from 25 to 27 seconds, but it is quite likely that the results would not be so uniform.

A set-up for hardening a gear cut integral with a shaft is illustrated in Fig. 5. The gear is mounted between centers, and the induction coil surrounds only the section to be hardened. The fixture includes a base, a quench ring, and a copper-tube induction coil. The gear measures 2 1/2 inches in diameter, and is heated in 10 seconds, followed by a 6-second quench.

Again, the elimination of straightening is in favor of the induction-hardening process for gears of this type. For example, with such a gear as shown, it is

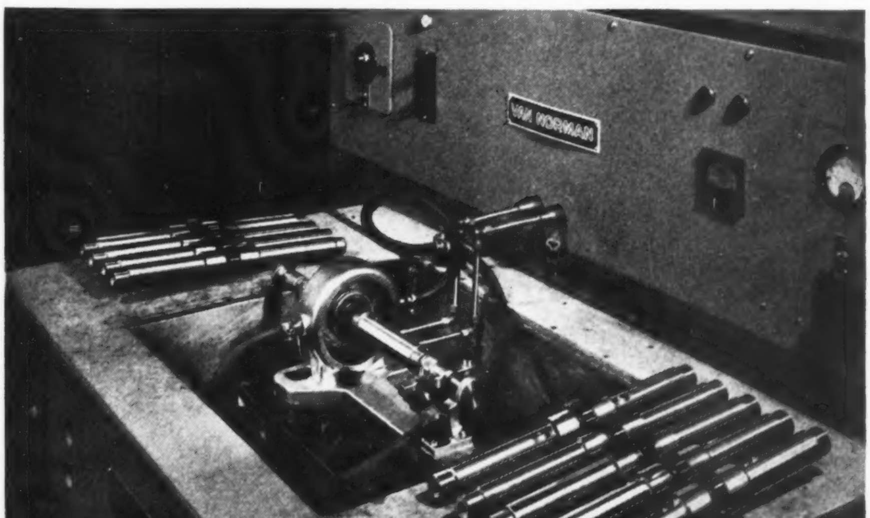


Fig. 5. Fixture Arranged for Hardening a Gear that is Cut Integral with Its Shaft

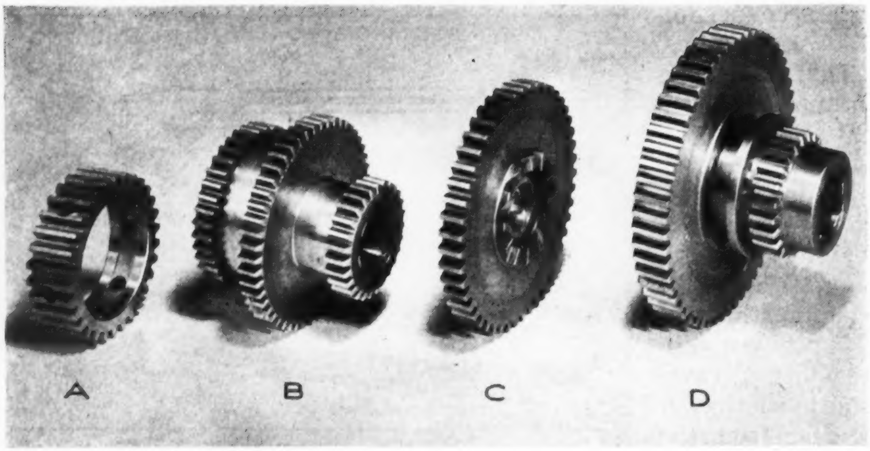


Fig. 7. When and when Not Distortion may be Expected in Different Types of Gears

likely that some warpage or deformation would result if the entire part were heated for hardening the teeth. As a result, it would be necessary to add a straightening operation, which at times can be quite troublesome. With induction hardening, however, since the heat is localized in the gear teeth only, no warpage takes place, and the usual straightening operation can be eliminated.

In hardening gears by high-frequency heat, very little distortion takes place in the average gear. However, there are naturally some designs in which deformation will occur. Referring to Fig. 7, the gear at *A* is thin in section, and regardless of the kind of heating that is applied, there is likelihood of some distortion; induction heating would be no exception.

The gear shown at *C*, however, is solid, and when hardened by high-frequency heat, there will be practically no change in size or shape of the gear. Many tests have been conducted before and after hardening gears of this type, and at the very most, there might be a slight increase in size at the pitch diameter, but the concentricity will remain unchanged. Usually, if a gear will change one way or the other, it can be very quickly detected after one or two tests, so that proper allowances can be made in machining the teeth.

The example shown at *D* is a double-cluster gear which has a multi-spline machined in the hole. When the larger gear is hardened, there will be no distortion; but when heat is applied to the small gear, the splined hole is very likely to close in slightly, depending, of course, upon the wall thickness between the hole and the outside of the teeth. However, since only the contour of the gear teeth is hardened, the material around the hole will be unaffected, as far as hardness is concerned, and it is possible to rebroach the hole with a hand broach to remove any deformation that might have occurred.

The example shown at *B* is a triple cluster with three gears of different diameters, all of which are hardened separately. Here, again, if the amount of material between the hole and the teeth is thin, there is likely to be some closing in of the hole.

By having full knowledge of what is needed to harden gears successfully by the high-frequency induction process, it is possible to incorporate these requirements in the original design. Generally speaking, induction hardening can be applied to, perhaps, 90 per cent of all gears in the range that this method covers; and the few that might give trouble can very often be corrected by slight modifications in design—usually in proportioning the amount of steel around the gear so deformation will not take place.

In Fig. 8 is illustrated a set-up for hardening one of the gear sections of the

Fig. 8. Hardening One of the Gear Sections of a Triple-cluster Gear

triple-cluster gear. In hardening a gear of this type, it is the usual practice to harden the smallest gear first, next the medium sized gear, and then the largest gear as a final operation. The reason for this is that the location of the induction coil for the smaller gears is close to the face of the large gear, and if the large gear were hardened first, a slight amount of heat might be generated in it, with a slight drawing effect, when the smaller gears were heated; but by hardening the large gear last, it is obvious that the heat will be confined to the place where it is wanted and will have no effect on the other gears.

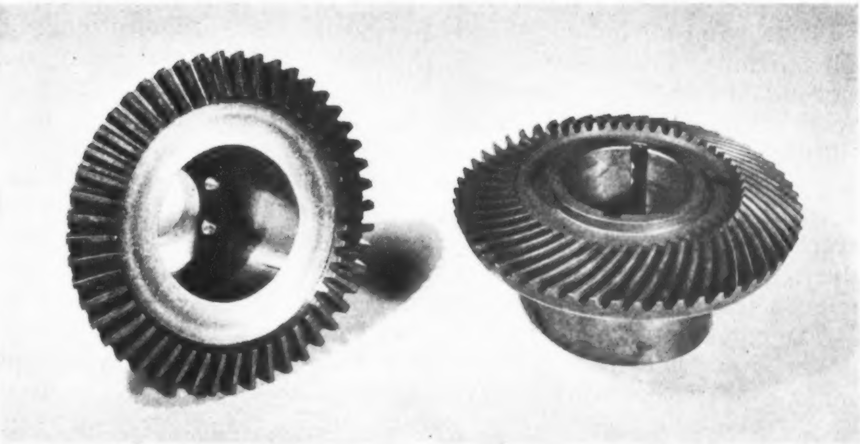


Fig. 9. Straight and Spiral Bevel Gears can also be Hardened by the Induction Heating Method

In hardening bevel gears by means of high-frequency heat, the same general procedure as is used for spur gears is applied. The induction coil is wound helically to conform to the face angle of the gear. On straight-tooth bevel gears, as shown at the left in Fig. 9, the heat pattern follows the contour of the teeth, and uniform surface hardening can be easily obtained. With spiral-bevel gears, however, the eddy currents are disturbed to such an extent that there is a tendency to obtain more heat on one side of the tooth than on the other.

On some sizes of spiral-bevel gears, this can be overcome by applying slightly more heat to insure hardening of the concave side. On other forms of spiral bevel gears, however, the best practice is to carburize the gear after the teeth have been rough-cut, then follow with the finish-cutting operation, after which the teeth can be induction-hardened by applying sufficient time to heat the entire tooth. When the gear is quenched, only the carburized surface will become hardened. While the expense of carburizing adds to the cost of manufacture, there is the decided advantage of lower heating cost and the absence of scale, as well as the elimination of distortion.

A bevel gear that is easily hardened by means of high-frequency induction heating and that might offer some difficulties under usual procedures is illustrated in Fig. 6. The design called for a hub to extend from in front of the face, which naturally had to be assembled after the gear had been cut. If the gear were hardened first and then brazed in place, the heat of brazing might draw the temper from the teeth. With high-frequency heating, however, it is possible to first braze the shaft into the hub of the gear and then follow with a hardening operation on the teeth only. The fixture used for hardening this gear is illustrated in Fig. 10. The gear is 3 1/4 inches in diameter, and requires a heating time of 12 seconds, followed by a quench of 6 seconds.

In hardening spur or bevel gears by the induction heating process, the work should be rotated either by power or manually, in order to insure uniform heating. While it would be pos-

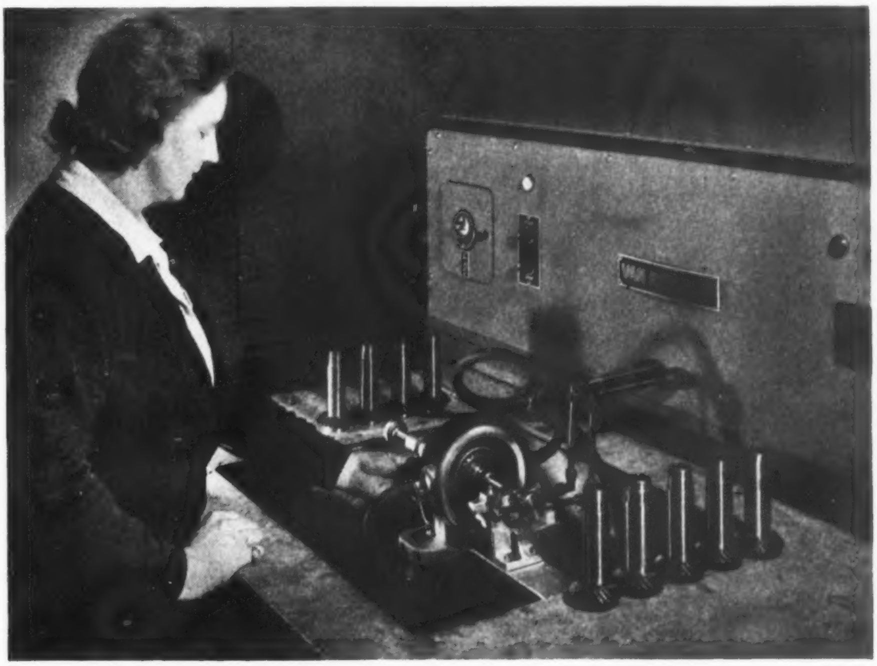


Fig. 10. Fixture Used for Hardening the Gear Shown in Fig. 6

sible to wind an induction coil that would heat all portions of the gear blank uniformly, it is not easy to do this. Therefore, by turning the work, it is easy to compensate for any slight difference in spacing between the coil and the work. The better method is to rotate the gear by means of a small motor, arranged so that the work turns at a speed of from 25 to 35 R.P.M. during the heating cycle only. As soon as the quench is applied, rotation stops automatically.

The current cost for the induction heating of gears is comparatively low. When a 35-K.W. input converter is used for heating the various types of gears shown, the heating cycle averages only about one-third of the total hardening time. The balance is consumed in quenching, removing and loading the work, and changing the fixture from one job to another. Assuming the power cost to be $0.02 per K.W., the operating cost for current would be from $0.22 to $0.24 per hour, based on 20 minutes of heat cycle. The number of pieces that can be processed in an hour depends on the size of the gears, but the average would run somewhere between 50 and 60, so that the average current cost per gear would be less than one-half cent.

Electronic Brazing Equipment for Carbide Tools

ELECTRONIC induction equipment for the production brazing of carbide tools using any suitable brazing medium, including copper, has been made available by the Carboloy Company, Inc., Detroit, Mich. Recommendations as to the size of the unit or units, basic coil designs, etc., are supplied by the engineering department of the company.

The Carboloy induction tool-brazing equipment is based on a new line of General Electric Co.'s high-frequency (500,000-cycle) electronic-tube oscillators, available in two sizes having 5- and 15-kilowatt output ratings. The 15-kilowatt unit is designed to accommodate larger sizes of tools, and can also be used for smaller tools by handling two or more pieces at a time. The 5-kilowatt unit is designed primarily for brazing the smaller tools.

Induction Brazing Carboloy Cemented-carbide Tool with Carboloy-G.E. Electronic Equipment

In addition to the oscillator, the only equipment required for brazing tools by the electronic tube induction method is a table carrying a tool-holder fixture or fixtures and the necessary water-cooled coils to be connected electrically to the terminals of the oscillator. In using the equipment, the operator merely attaches a coil of the correct shape and size for the tool to be brazed, sets the control dials of the oscillator to the proper values with respect to current and timing, and pushes a button. The equipment automatically completes the brazing operation. The coils are simple to fabricate, and can be formed in a few minutes' time from ordinary copper tubing by the user for special brazing operations.

* * *

Motion Pictures for Training Lathe Operators

Two 16-millimeter sound films, in color, have been placed at the disposal of industry by the South Bend Lathe Works. One of these films—"The Metal-Working Lathe"—is intended to quickly familiarize the beginner with the name of each principal lathe part and its purpose, and with the general operation of a lathe. The second film—"Plain Turning"—demonstrates the machining of a shaft held between lathe centers. Many basic lathe operations are clearly shown by close-up views in this film. Information on how to secure these two training films can be obtained from the South Bend Lathe Works, South Bend, Ind.

The value of motion pictures for training purposes is being more and more appreciated. These films should serve a very useful purpose.

MACHINERY'S DATA SHEETS 493 and 494

POLAR MOMENT OF INERTIA I_p AND POLAR SECTION MODULUS Z_p OF SOLID CIRCULAR SECTIONS—1

Computations of twisting moments and angles of torsion for round solid and tubular shafting are facilitated by the use of Data Sheet No. 494. For each shaft diameter, two values are shown; the upper value is the polar moment of inertia I_p and the lower value the polar section modulus Z_p.

To find polar moment of inertia for a round solid shaft of 6 5/8 inches diameter, follow horizontally from number 6 in first column to column headed 5/8, where upper value is 189.1. To find polar section modulus for a shaft 9 1/4 inches in diameter, follow horizontally from number 9 to column headed 1/4, where lower value is 155.4.

Example 1—What twisting moment or torque will produce a maximum shearing stress of 11,000 pounds per square inch in a solid shaft 3 3/8 inches in diameter?

Let M = twisting moment or torque, in inch-pounds; S_s = shearing stress at most remote fiber from center (maximum stress will be at a distance equal to radius of section from center), in pounds per square inch; and Z_p = polar section modulus. Then

$$M = S_s Z_p = 11{,}000 \times 7.548$$
$$= 83{,}028 \text{ inch-pounds or } 6919 \text{ foot-pounds}$$

Example 2—What is angle of torsional deflection in a length of 8 1/2 feet of shafting mentioned in Example 1, if torsional modulus of elasticity is 12,000,000?

Let M = twisting moment or torque, in inch-pounds; i = angle of torsional deflection, in radians; x = length of bar, in inches; G = torsional modulus of elasticity, in pounds per square inch; and I_p = polar moment of inertia. Then

$$i = \frac{Mx}{GI_p} = \frac{83{,}028 \times 8.5 \times 12}{12{,}000{,}000 \times 12.74}$$
$$= 0.0554 \text{ radians, or 3 deg. 10 min. 26 sec.}$$

To find polar moment of inertia of hollow cylindrical tube, subtract polar moment of inertia of solid section having diameter equivalent to internal diameter of tube from polar moment of inertia of solid section having diameter equivalent to external diameter of tube.

Example 3—What is polar moment of inertia of tubular section with internal diameter of 11 5/8 inches and external diameter of 12 3/4 inches?

Let I_p = polar moment of inertia of this tubular section; A = polar moment of inertia of a solid section with diameter of 12 3/4 inches; and B = polar moment of inertia of a solid section with diameter of 11 5/8 inches. Then

$$I_p = A - B = 2594 - 1793 = 801$$

To find polar section modulus of hollow cylindrical tube, subtract polar moment of inertia of solid section having diameter equivalent to internal diameter of tube from polar moment of inertia of solid section having diameter equivalent to external diameter of tube, and divide remainder by external radius of tube.

Example 4—Find polar section modulus of tubular section mentioned in Example 3.

Let Z_p = polar section modulus of this tubular section; A = polar moment of inertia of a solid section with diameter of 12 3/4 inches; B = polar moment of inertia of a solid section with diameter of 11 5/8 inches; and r = external radius of tube, in inches. Then

$$Z_p = \frac{A - B}{r} = \frac{2594 - 1793}{6.375} = 125.6$$

For sections larger in diameter than those shown in table, values of polar moment of inertia and polar section modulus may be found as follows:

Take values for section of one-half required diameter, and multiply polar moment of inertia by 16 and polar section modulus by 8. Should one-half required diameter be beyond upper limit of table, take values for section of one-quarter required diameter, and multiply polar moment of inertia by 256 and polar section modulus by 64.

Compiled by R. Parkes
Machine Designer, Holland, Mich.

POLAR MOMENT OF INERTIA I_p AND POLAR SECTION MODULUS Z_p OF SOLID CIRCULAR SECTIONS—2

Upper values: Polar moment of inertia $I_p = \pi D^4 \div 32$.
Lower values: Polar section modulus $Z_p = \pi D^3 \div 16$.

Diam. D	0	1/8	1/4	3/8	1/2	5/8	3/4	7/8
0	I_p Z_p	0.00002 0.00038	0.00038 0.00307	0.0019 0.0103	0.0061 0.0245	0.0149 0.0479	0.0310 0.0828	0.0575 0.1315
1	0.0982 0.1963	0.1573 0.2796	0.2397 0.3835	0.3509 0.5104	0.4970 0.6627	0.6862 0.8425	0.9208 1.052	1.213 1.294
2	1.571 1.571	2.002 1.884	2.516 2.236	3.124 2.630	3.835 3.068	4.661 3.551	5.615 4.083	6.707 4.664
3	7.952 5.301	9.363 5.992	10.95 6.740	12.74 7.548	14.73 8.418	16.95 9.353	19.41 10.35	22.14 11.42
4	25.13 12.57	28.42 13.73	32.03 15.07	35.97 16.44	40.26 17.90	44.92 19.43	49.99 21.04	55.45 22.75
5	61.36 24.54	67.73 26.43	74.58 28.41	81.94 30.49	89.84 32.67	98.30 34.95	107.3 37.33	117.0 39.82
6	127.2 42.41	138.2 45.12	149.8 47.94	162.2 50.87	175.2 53.92	189.1 57.10	203.8 60.40	219.3 63.80
7	235.7 67.35	253.0 71.02	271.2 74.82	290.4 78.76	310.6 82.84	331.9 87.05	354.2 91.40	377.6 95.90
8	402.1 100.5	427.9 105.3	454.8 110.3	483.0 115.3	512.5 120.6	543.3 126.0	575.5 131.5	609.1 137.3
9	644.1 143.1	680.7 149.2	718.7 155.4	758.4 161.8	799.6 168.3	842.6 175.1	887.2 182.0	933.6 189.1
10	981.7 196.3	1032 203.8	1084 211.4	1138 219.3	1193 227.3	1251 235.5	1311 243.9	1373 252.5
11	1437 261.3	1504 270.4	1573 279.6	1644 289.0	1717 298.6	1793 308.5	1871 318.6	1952 328.9
12	2036 339.3	2124 350.0	2211 361.0	2304 372.1	2397 383.5	2495 395.1	2594 407.0	2699 419.0
13	2804 431.4	2915 444.0	3026 456.8	3143 469.9	3261 483.2	3385 496.7	3509 510.4	3640 524.4
14	3771 538.8	3909 553.5	4048 568.2	4194 583.4	4340 598.6	4493 614.4	4647 630.1	4809 646.4
15	4970 662.7	5140 679.5	5310 696.4	5488 713.8	5667 731.2	5854 749.1	6041 767.1	6237 785.7

Compiled by R. Parkes
Machine Designer, Holland, Mich.

Meeting of Metal Trades Association

THE theme of the annual meeting of the National Metal Trades Association, recently held in Chicago, was "Production—Key to Victory." The program was planned to bring before the assembled leaders in the metal industries the experience and knowledge of outstanding men in industrial management, business, education, and government. All the addresses made before the meeting were directly related to the problems created by industry's war production effort. The entire program was arranged to aid industry in doing an even more effective job than has been accomplished in the past in the production of war equipment.

Roe S. Clark, Re-elected President of the National Metal Trades Association

Among the many addresses made before the Association, those mentioned in the following were particularly aimed at solving current problems. Phil Carroll, Jr., management consultant, New York City, spoke on "Incentive—A Key to Increased Production." Mr. Carroll has had wide experience in incentive time-study and management work, and his remarks were based upon personal knowledge of the practical application of time study to wage-incentive plans, budgets, inventory control, and standard costs.

In his address "How to Use Job and Salary Rating," E. L. Berry, vice-president of the Link-Belt Ordnance plant, Chicago, Ill., spoke from many years of experience in the field of industrial relations. Mr. Berry is well known in industry as one of the leaders in the establishment of successful apprentice training methods. He has also developed an effective program for utilizing job and salary ratings for manufacturing plants in the metal industry.

S. J. Kellerman, of the Curtiss-Wright Corporation, St. Louis, Mo., spoke on "Foremen Relations," and Thomas O. Armstrong, manager of industrial relations, Westinghouse Electric & Mfg. Co., Springfield, Mass., spoke on "Making Good Labor Practices Work." Both of these men have had wide experience in the fields covered. Mr. Kellerman's success in helping to solve foremen's problems enabled him to discuss this subject authoritatively. Mr. Armstrong, during his eighteen years with the Westinghouse organization, has worked in the capacity of foreman, purchasing agent, office employment manager, and supervisor of industrial relations. He is particularly well versed in the subject of labor relations and executive training.

"The Post-War Outlook for the Metal Industries" was comprehensively covered in an address by John H. Van Deventer, president and editor of *The Iron Age*. An address of particular interest to the men engaged in medium- and small-sized organizations was given by Carl E. Bolte, of the Smaller War Plants Corporation, Washington, D. C., who spoke on "Small Business and Its Place in the War Effort."

Roe S. Clark, vice-president and treasurer of the Package Machinery Co., Springfield, Mass., was re-elected president of the Association; H. H. Kerr, president of the Boston Gear Works, North Quincy, Mass., was re-elected first vice-president; and George A. Seyler, vice-president in charge of manufacturing of the Lunkenheimer Co., Cincinnati, Ohio, was re-elected second vice-president.

Reclaiming Oil from the Air

In high-speed machine tools, cooling oil is sometimes used at a rate as high as five gallons a minute. Much of the oil pouring on fast cutting tools is whipped into a fine spray, and the cutting-edge temperatures may even turn the oil to smoke; often the air becomes filled with spray and smoke. The oil-laden air is drawn upward toward the exhaust-air intake. Oil condenses on lighting fixtures, electrical insulation, and the walls. The oil mist can be caught by an air-conditioning system, but the harm is done before the oil reaches the intake ducts.

The best solution seems to be to remove the vaporized oil at each machine. With a Precipitron built into the machine tool itself, Westinghouse engineers, in a trial installation on one machine, filtered four to five gallons of cutting oil out of the air in one day. Visibility is improved, building maintenance is greatly reduced, and the life of power and light cables and controls is very materially lengthened by the Precipitron installation.

Direct-Current Adjustable-Speed Drives for Machine Tools

Development of the Adjustable-Voltage, Direct-Current Drive has Resulted in Many Variations with Improved Characteristics, Suitable for a Wide Range of Machine Tool Applications. Five Forms of This Type of Drive are Described in a Series of Three Articles, of which This is the Last

By G. A. CALDWELL, Industry Engineering Department
Westinghouse Electric & Mfg. Co.

IN the first two articles of this series, the characteristics of the conventional adjustable-voltage, the series variable-voltage, and the self-excited adjustable-voltage drives were discussed. The fourth variation, or wide speed-range adjustable-voltage drive, will now be described. This drive utilizes the units normally employed in a conventional adjustable-voltage control with the addition of the Rototrol unit.

Any direct-current adjustable-voltage drive operating over speed ranges in excess of 10 to 1 by variable-voltage control requires compensation for certain characteristics at low speed that are not important at high speed. The two most important factors are the residual voltage of the generator and the IR drop of the system.

Most commercial generators have a residual voltage of between 3 and 4 per cent of their normal operating voltage. This means that the no-load speed of the motor which is being driven by such a generator in an adjustable-voltage control drive is limited to a no-load speed range of about 25 to 1, since the residual voltage will not permit a voltage lower than itself to exist. For voltage ranges in excess of 25 to 1 it is necessary to make some arrangement to overcome this residual voltage. Also, since the residual voltage is a function of the previous magnetic history of the generator, it is necessary that the equipment used to overcome the residual voltage be able to adjust itself properly to the actual conditions.

The speed of a direct-current motor will normally drop as the load is applied, due to the IR drop of the system. Since a feed mechanism or similar drive must run at constant speed, regardless of the load, it is necessary that the speed-torque characteristics of the motor driving the feed be practically flat. Because the normal drop in speed of a direct-current motor is almost entirely due to the IR drop, some arrangement must be made to increase the applied voltage of the generator by the amount of the IR drop as the load is applied, so that the induced voltage, and therefore the speed of the motor, will remain constant. These requirements indicate that some means of regula-

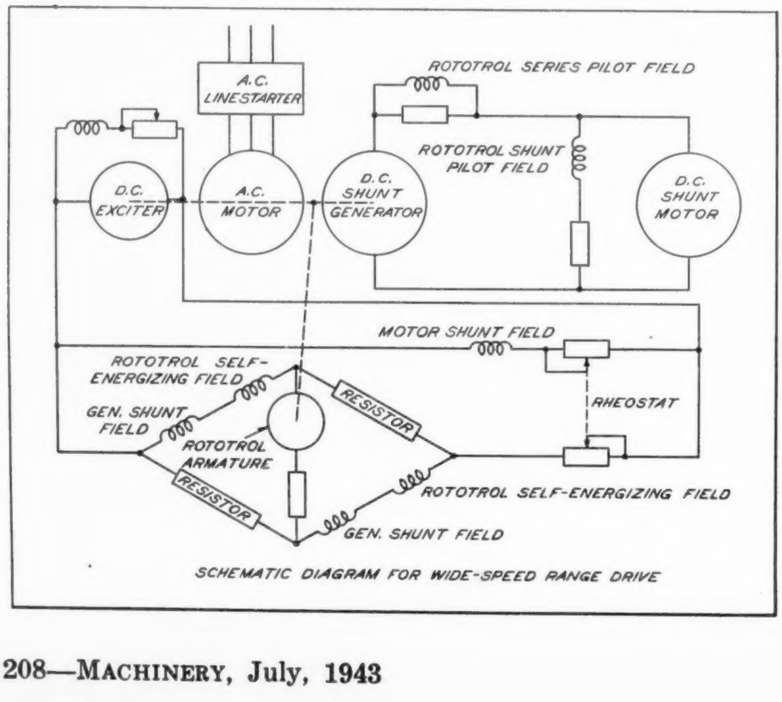


Fig. 12. Utilizing a Rotating Voltage Regulator, Called a Rototrol, to Compensate for Generator Residual Voltage and Total System IR Drop Permits a 120 to 1 Speed Range in This Wide Speed-range Adjustable-voltage Drive

tion must be supplied in order to maintain the desired speed characteristics. It has been found by experience that a rotating regulator is satisfactory for this particular function, and this has been widely applied.

This type of rotating regulator, called a Rototrol, was first developed for elevators, and a large installation was made in Radio City, New York, in 1934. Since that time, the Rototrol has been used in many industrial applications. It is the heart of the variable-voltage planer, and has been proved in service over a period of years. Other applications include paper mill drives, electric shovels, and blast-furnace skip hoists. In appearance, it looks the same as the standard direct-current generator, and is usually mounted as a unit on the variable-voltage generator set.

Rototrol for Constant-Speed Regulation

It is not our purpose here to describe the electrical circuit of the Rototrol in detail or to explain the theory on which it works. However, its basic circuit, when applied to regulating for a constant speed, is shown in Fig. 12. The main generator field is connected in a special bridge circuit with the resistance values of the field, and the separate resistor units are so selected that there is no potential difference between the points where the Rototrol armature is connected. The Rototrol armature, by generating a voltage, will circulate current through the generator shunt field and the Rototrol self-energizing field, and modify the excitation of the main generator primarily determined by the exciter bus voltage and the setting of the control rheostat.

At no load, the Rototrol shunt pilot field, connected across the terminals of the direct-current shunt motor, just balances the Rototrol self-energizing fields, so that zero excitation and output of the Rototrol armature results. The Rototrol shunt pilot and series pilot fields are so proportioned that, for any load condition, the net excitation in the Rototrol unit is proportional to the counter-E.M.F. of the motor. With an increase in motor load, resulting in an increase in armature current, the excitation provided by the Rototrol series pilot field will increase. Furthermore, a reduction in the main generator voltage under load will serve to decrease the excitation provided by the Rototrol shunt pilot field.

The net result of these interactions is an output voltage of the Rototrol armature which circulates current through the Rototrol self-energizing fields and main energizing fields, supplementing the excitation that the main generator field receives from the exciter bus. The Rototrol balance, or point of zero current

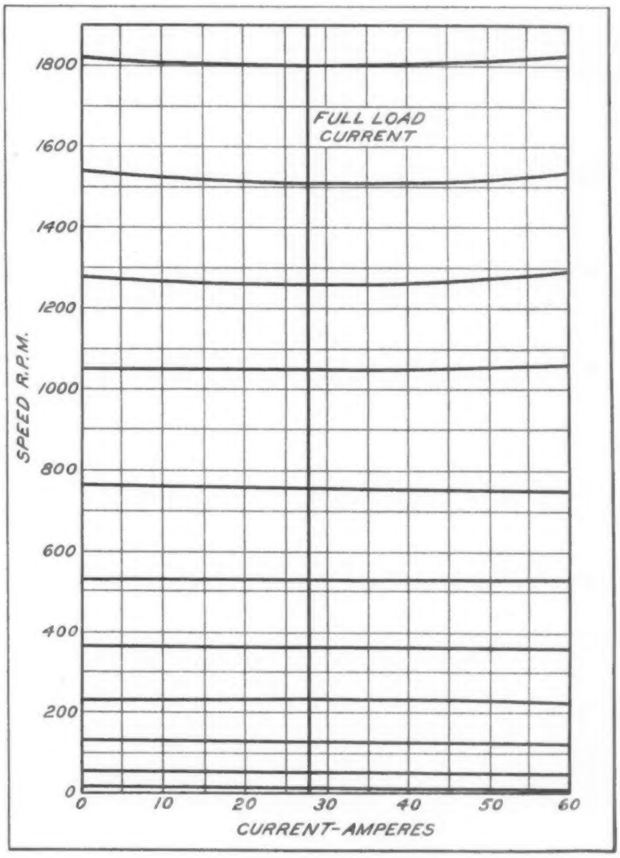


Fig. 13. Use of a Rototrol in a 7 1/2-H.P. Machine Tool Feed Drive Holds Speed Variation to Negligible Amount at Speed Settings from 15 to 1800 R.P.M., as Shown by Flat Curves

output, will be restored when the main generator voltage increases sufficiently to restore the motor speed to the correct value. Thus, the Rototrol series pilot field serves to compensate the circuit for the resistance drop in the lines and motor armature, and the Rototrol shunt pilot field serves to compensate the circuit for the resistance drop as well as magnetizing effects which occur in the main generator armature.

The results that can be obtained by the correct application of the Rototrol unit to the conventional adjustable-voltage control are indicated in Fig. 13. These curves are actual tests on a 7 1/2-H.P. machine tool feed equipment using the Rototrol just described. The curves show the regulation of the motor to double full-load current over a range from 15 R.P.M. to 1800 R.P.M., or a total range of 120 to 1. Of this range, speeds of approximately 1000 R.P.M. down to 15 R.P.M. are obtained by adjustable-voltage control, and those from 1000 R.P.M. up to 1800 R.P.M. by motor field control.

It can be seen by reference to these curves that the change in speed with the application of the load is so small as to be negligible, and there is no tendency for the motor to stall, even when

the speed has been reduced to one-sixtieth by voltage control. It is to be noted that, at light loads at this speed, the voltage required is less than the residual voltage of the generator. The regulator has caused the reversal of current in the field of the generator to buck down the voltage to give the proper speed required at no load. As the load is increased, it again restores the current to its original direction to build up the voltage sufficiently to overcome the resulting IR drop.

From these results it is evident that the use of the Rototrol in an otherwise conventional adjustable-voltage control scheme gives a speed range far beyond the limits thought possible a few years ago, without greatly complicating the electrical apparatus or going to laboratory type of equipment. Several drives of this type have been supplied during the last two years for feed drives of various types of machine tools. Since practically the entire range of these drives is obtained by variable-voltage control, they are essentially constant-torque drives, and are particularly adapted to feed drives where a wide speed range at constant torque is required.

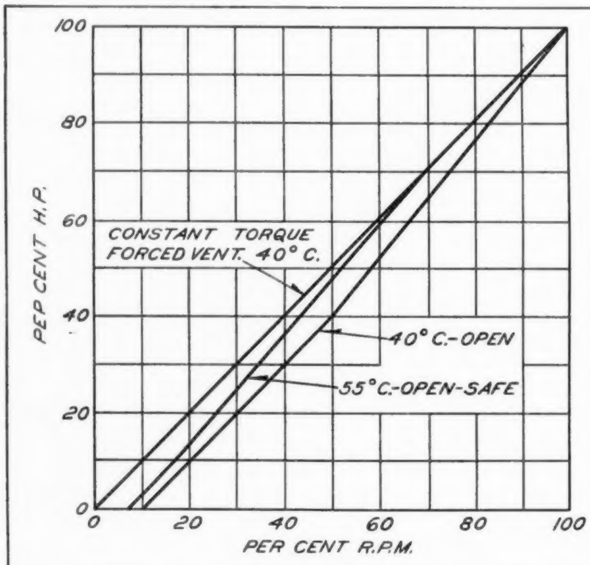
Relative Advantages of the Five Forms of Adjustable-Voltage Drives

TYPE	SIMPLICITY	COST	SPEED RANGE			SPEED REGULATION
			VOLTAGE CONTROL	FIELD CONTROL	TOTAL	
SERIES VARIABLE-VOLTAGE	1	1	10 TO 1	0	10 TO 1	4
SELF-EXCITED ADJUSTABLE-VOLTAGE	2	2	3 TO 1	4 TO 1	12 TO 1	4
CONVENTIONAL ADJUSTABLE-VOLTAGE	3	3	10 TO 1	4 TO 1	40 TO 1	2
ELECTRONIC ADJUSTABLE-VOLTAGE	4	4	10 TO 1	4 TO 1	40 TO 1	3
WIDE-SPEED RANGE ADJUSTABLE-VOLTAGE	5	5	60 TO 1	2 TO 1	120 TO 1	1

SPEED RANGE BY FIELD CONTROL GIVES CONSTANT HORSEPOWER
" " " VOLTAGE " " " TORQUE

Electronic Adjustable-Voltage Drive

A fifth general classification of adjustable-voltage drives is the type that uses the conventional direct-current motor with an electronic rectifier for its source of power instead of a motor-generator set. Experimental units have been in use for several years on various types of applications, and there is no doubt but what there will be further developments and applications of this type of adjustable-voltage control. At the present time, the equipment is rather limited in size and speed range. The electronic adjustable-voltage control is also more expensive than the conventional adjustable-voltage control using a motor-generator set.



RELATION OF HORSEPOWER AND SPEED OF ADJUSTABLE-VOLTAGE MOTORS

Fig. 14. A Constant-torque Drive may Show Variation in Ratio of Horsepower to Speed due to Relatively Poorer Dissipation of Heat Losses at Low Speeds. As Shown by Upper Curve, Forced Ventilation Corrects This Variation

The normal unit uses two electronic tubes to give single-phase full-wave rectification, with power supplied to the tubes by a suitable primary transformer. In addition to the main-circuit rectifier tubes, there is a set of smaller tubes used to give direct-current power for the field circuit. Not only is this unit more expensive, so far as the rectifying equipment is concerned, but, in order to obtain a given rating from the driving motor, a larger frame size may be required than for conventional adjustable-voltage control. This is due to the fact that the direct current, even at full voltage, is pulsating, and this sets up additional losses in the motor. The speed range is obtained by means of grid control, which makes the direct current even more pulsating at low speed, increasing motor losses and motor heating.

This type of control equipment will probably have its greatest appeal to machine tool manufacturers in cases where there is a need for a fairly wide speed range, but where the mounting of a motor-generator set is objectionable, either from the standpoint of space or vibration. The vibration problem is especially important on certain types of grinders that are used for obtaining high finishes. The principal disadvantages of this type of equipment at present are its high cost and the fact that maintenance men are not familiar with it.

Motor Ventilation a Factor in Constant-Torque Drive Output

Before summarizing the various types of drives, I would like to bring out one point that is frequently overlooked when applying an adjustable-voltage drive having a fairly wide speed range. It is often stated that a motor operating over a wide range by voltage control has constant torque. Such a statement is not quite true, owing to the fact that a motor running at low speed is not ventilated as well as a motor running at higher speeds, and therefore the heat losses in the machine are not dissipated to the same extent. Hence, a motor carrying constant current over a wide range of speed will run hotter at low speed than at high speed.

Although this effect will vary with the size and design of the motor, the approximate relation of torque rating to the speed of the motor is shown in Fig. 14. These curves are based on a motor running at its rating continuously at a 40-degree C. rise and its base full speed. They are also based on the motor being supplied without enclosing covers. The addition of any form of protective covering increases the temperature rise at any given speed. In the case of many of the larger motors, where it is desired to have them well protected and at the same time operate over a wide speed range, forced ventilation may be easily justified, as this gives normal ventilation of the motor at any speed, and it is therefore really a constant-torque application.

Comparison of the Five Forms of Adjustable-Voltage Drives

A comparison of the various types of adjustable-voltage drives on the basis of simplicity, cost, speed range, and speed regulation is given in the accompanying table. The series variable-voltage drive rates first in regard to simplicity and cost. However, it is limited in its speed range and does not have as good voltage regulation as some of the other drives. It is particularly adaptable to drives requiring constant torque in their application and high starting torques. It is not suitable for rapidly fluctuating loads nor is it particularly suitable for rapidly reversing loads.

The self-excited adjustable-voltage drive rates next to the series variable-voltage type in regard to simplicity and cost, and has a comparable speed regulation. It has approximately the same speed range, and can be used for the same general type of applications, but it has an advantage in that it can be used more readily on rapidly fluctuating loads, and various control features can be more easily applied. This drive also is well adapted to applications that require high torques at low speeds, as the drive operates over a 4 to 1 speed range at constant horsepower.

The conventional adjustable-voltage drive is applied in certain cases requiring speed ranges in excess of those obtainable on the simplified drives just mentioned. The drive is naturally more elaborate and expensive, but it has a better speed regulation, and is more flexible when it comes to adding special control features.

The electronic adjustable-voltage control is more expensive, and usually more complicated, than the conventional adjustable-voltage control drive. It has about the same speed range, although the simplified form has a poor speed regulation. The principal advantage is that the motor-generator set, with its vibration and mounting problem, is eliminated.

The wide speed-range adjustable-voltage drive is naturally more elaborate and more expensive than the other drives, but this is balanced by the fact that the Rototrol unit gives it a much wider speed range and better speed regulation than any other form of adjustable-voltage drive.

These five drives represent what the electrical industry has to offer in the way of adjustable-speed drives, and all of them are actually in use on various types of machine tool applications. There is no doubt but what many additional applications will be made in the near future.

* * *

New Spring Construction for Dampening Vibration and Deadening Sounds

A device embodying a patented spring construction with a mounting so designed that thrust can be taken from any direction has been developed by the Rande Specialty Co., Hoboken, N. J., for the purpose of dampening vibration, deadening sound, and absorbing shock in machine operation.

The device consists of a number of cells, each with a spring mounted in it. These cells are fabricated into a unit, on the principle of a mattress, but each cell deflects independently. The units are easily applied to a wide variety of uses, either singly or in multiple blocks. The standard unit is a nine-cell construction—three cells in each direction—with a 100-pound load capacity and occupying a space of 2 1/2 by 2 by 5/8 inch.

Any weight within the capacity of the equipment can be floated by placing the required number of 100-pound unit springs together on a solid footing under a machine base or other load. A group of thirty-six unit springs, for example, will occupy approximately one square foot, and will float 3600 pounds. These unit springs have been used for five years on rolls and presses in laundries, but are now available for wider applications.

New Trade Literature

RECENT PUBLICATIONS ON MACHINE SHOP EQUIPMENT, UNIT PARTS, AND MATERIALS

To Obtain Copies, Fill in on Form at Bottom of Page 213 the Identifying Number at End of Descriptive Paragraph, or Write Directly to Manufacturer, Mentioning Catalogue Described in the July Number of MACHINERY

Mounted Grinding Wheels

BAY STATE ABRASIVE PRODUCTS Co., Westboro, Mass. Booklet containing complete data on Bay State standard shapes and sizes of mounted grinding wheels and points. Circular descriptive of the method of forming Bay State mounted wheels and points from uniform blanks, which assures a constant grade of hardness. 1

Universal Shaft Joints and Assemblies

BROOKS EQUIPMENT CORPORATION, 90 West St., New York City. Catalogue containing data on Beco shaft joints and assemblies of the hinged and universal types, the latter having operating ranges from 0 to 360 degrees in any plane. 2

Small Fine-Pitch Hobs

BARBER-COLMAN Co., 204 Loomis St., Rockford, Ill. Catalogue entitled "Facts About Small Fine-Pitch Hobs," containing information on the characteristics of these hobs and methods of using and sharpening them, together with production data. 3

Metal Cleaning Handbook

MAGNUS CHEMICAL Co., INC., Garwood, N. J. Metal cleaning handbook (72 pages), containing information on the selection of cleaning materials, methods of use, and types of washing equipment best adapted for cleaning various shapes of metal articles. 4

Taps

THREADWELL TAP & DIE Co., Greenfield, Mass. Booklet entitled "How to Sell Threadwell Taps to Industrial Users," containing basic information on the design, construction, and use of taps, as well as helpful suggestions for salesmen. 5

Boring-Bar Operator's Manual

McCROSKY TOOL CORPORATION, Meadville, Pa. Manual for users of McCrosky adjustable boring-bars, containing complete information on the design and construction of these bars and their correct use, including instructions for regrinding. 6

Electrode Comparison Chart

AIR REDUCTION Co., 60 E. 42nd St., New York City. Electrode Comparison Chart, giving the principal AWS and ASTM electrode classifications and listing the electrodes produced by twenty leading manufacturers to meet the different requirements. 7

Mounted Grinding Wheels

GRINDING WHEEL MANUFACTURERS ASSOCIATION, 27 Elm St., Worcester, Mass. Bulletin containing information on the principles of safe and efficient operation of mounted grinding wheels and points, together with tables of critical speeds. 8

Handbook for Welding and Cutting

INTERNATIONAL ACETYLENE ASSOCIATION, 30 E. 42nd St., New York City. "Handbook for the Welding and Cutting Operator," containing information of value to users of the oxy-acetylene welding and cutting processes. 9

Lignum-Vitae in the War Effort

LIGNUM-VITAE PRODUCTS CORPORATION, 96-100 Boyd Ave., Jersey City, N. J. Publication entitled "An Important Wartime Report for Production and Engineering Executives—How Lignum-Vitae is Being Used for Mechanical and Industrial Purposes." 10

Blueprints and Other Reproductions of Tracings

PARAGON-REVOLUTE CORPORATION, 77 South Ave., Rochester, N. Y. Handbook of Print-Making and Processing (40 pages, 8 1/2 by 11 inches), covering blueprints, sepia negatives, direct process prints, and reproduced tracings. 11

Special-Purpose Machines

FITCHBURG ENGINEERING CORPORATION, Fitchburg, Mass. Catalogue illustrating and describing some of the many types of milling and boring machines built by this company to solve special production problems. 12

Preparing Metal Surfaces for Black Oxide Finishing

OAKITE PRODUCTS, INC., 26 Thames St., New York City. Booklet containing technical data on the preparation of ferrous and non-ferrous metal surfaces for black oxide finishing. 13

Precision Lathes

SOUTH BEND LATHE WORKS, South Bend, Ind. Catalogue 10, descriptive of South Bend 10-inch tool-room and quick-change gear precision lathes. Catalogue 14-C, on South Bend 14 1/2-inch tool-room lathes and engine lathes. 14

Tube-Bending Machines for Aircraft Work

WALLACE SUPPLIES MFG. Co., INC., 1300 Diversey Parkway, Chi-

cago, Ill. Bulletin 33, Section A3, descriptive of hydraulic automatic tube-bending machines for aircraft work. 15

Machine for Rapidly Identifying Steel

DRAVO CORPORATION, Machinery Division, 300 Penn Ave., Pittsburgh, Pa. Bulletin 543, descriptive of the Identometer, an electrical instrument for the rapid identification of different kinds of steel. 16

Hydraulic Duplicating Equipment

TURCHAN FOLLOWER MACHINE Co., 8249 Livernois Ave., Detroit, Mich. Booklet on hydraulic duplicating equipment for lathes, planers, shapers, grinding machines, and milling machines. 17

Electric Bonder for Metallizing Operations

METALLIZING CO. OF AMERICA, 1330 W. Congress St., Chicago, Ill. Folder descriptive of the new Mogul electric bonder for preparing hardened metal surfaces for metallizing. 18

Spring Design

MID-WEST SPRING MFG. Co., 4632 S. Western Ave., Chicago, Ill. Manual of spring design, containing formulas and other engineering data covering various types of springs, as well as wire forms. 19

Air-Hardening Die Steel

FIRTH-STERLING STEEL Co., McKeesport, Pa. Bulletin SL-2002, describing composition, characteristics, heat-treatment, and applications of Cromoco air-hardening die steel for high production. 20

Cemented-Carbide Drawing Dies

CARBOLOY COMPANY, INC., 11147 E. Eight Mile Road, Detroit, Mich. 32-page manual on cemented-carbide dies for drawing wire, bars, tubing, and sheet metal. 21

Cemented-Carbide Milling Cutters

MCKENNA METALS Co., 147 Lloyd Ave., Latrobe, Pa. Catalogue entitled "Specialized Milling with Grayson-Kennametal Milling Cutters." 22

Rotary Tool-Carrier

PRODUCTION MACHINERY DEVELOPMENT Co., 4845 St. Aubin Ave., Detroit, Mich. Circular illustrating and describing the Matthew patented precision rotary tool-carrier for vertical milling machines. 23

White-Print Reproductions of Tracings

OZALID PRODUCTS DIVISION, GENERAL ANILINE & FILM CORPORATION, Johnson City, N. Y. Folder on Ozalid white prints—positive reproductions of original tracings. 24

Aircraft Chains

LINK-BELT Co., 307 N. Michigan Ave., Chicago, Ill. Engineering Data Book No. 1825, containing information for aircraft engineers specially applicable to the design of chains and sprockets for aircraft applications. 25

Forming-Press Dies

DREIS & KRUMP MFG. Co., 7416 Loomis Blvd., Chicago, Ill. Illustrated treatise, of 40 pages, entitled "Forming-Press Dies and Their Uses," giving detailed information. 26

High-Production Metal-Forming Machinery

YODER Co., W. 55th St. and Walworth Ave., Cleveland, Ohio. Circular covering the Yoder line of high-production metal-forming machinery. 27

Cleaning and Drying Compressed Air

LOGAN ENGINEERING Co., 4900 Lawrence Ave., Chicago, Ill. Bulletin 543, on the Aridifier, a device that cleans and dries compressed air. 28

Turbine-Electric Drives for Ships

GENERAL ELECTRIC Co., Schenectady, N. Y. Publication entitled "Turbine-Electric Drive for Ship Propulsion." 29

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listed on pages 212-214 (without charge or obligation), fill in below the publications wanted, using the identifying number at the end of each descriptive paragraph; detach and mail to:

MACHINERY, 148 Lafayette St., New York 13, N. Y.

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Precision Manufacturing

ACE MFG. CORPORATION, 1253 E. Erie Ave., Philadelphia, Pa. Booklet entitled "Fine Precision," describing the company's facilities for undertaking precision manufacturing. ... 30

Automatic Screw Machines

GEORGE GORTON MACHINE CO., 1316 Racine St., Racine, Wis. Catalogue on the new Gorton 16-A, precision automatic screw machine. ... 31

Hydraulic Equipment

HYDRAULIC MACHINERY, INC., 12825 Ford Road, Dearborn, Mich. Bulletin on hydraulic power units; also bulletin on hydraulic test units. ... 32

Electronic Adjustable-Speed Drive

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburgh, Pa. Booklet B-3256, illustrating and describing the Mot-O-Trol, an electronic adjustable-speed drive. ... 33

Arc-Welding Machines

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin GEA-1440J, illustrating and describing Type WD direct-current, single-operator arc-welders. ... 34

Carbide-Tool Grinders

WILLEY'S CARBIDE TOOL CO., 1340 W. Vernor Highway, Detroit (16), Mich. Folder describing two new carbide-tool grinders equipped for wet grinding. ... 35

Tap Data

GREENFIELD TAP & DIE CORPORATION, Greenfield, Mass. Third of a series of folders on the subject of taps and tapping, entitled "Twenty-two Reasons Why a Good Tap Can Go Wrong." ... 36

Transmissions for Machine Tools

WESTERN MFG. CO., 3400 Scotten Ave., Detroit, Mich. Bulletin illustrating and describing Western transmissions up to 30 H.P. for machine tools. ... 37

Duplicating Equipment

DETROIT UNIVERSAL DUPLICATOR CO., 749 E. Milwaukee Ave., Detroit, Mich. Bulletin D-60, entitled "What is Duplimatic and How Does It Work?" ... 38

Manganese Steel

AMERICAN BRAKE SHOE CO., Chicago Heights, Ill. Bulletin 543-G, entitled "Manganese Steel—the Toughest Steel Known for General Industry." ... 39

Universal Slotmaster

EXPERIMENTAL TOOL & DIE CO., 12605 Greiner Ave., Detroit, Mich. Bulletin on the Universal Slotmaster as applied to milling machines. ... 40

Centerless Grinding

CINCINNATI GRINDERS INC., Cincinnati, Ohio. 48-page instruction book entitled "Principles of Centerless Grinding." ... 41

High-Temperature Lubricant

ACHESON COLLOIDS CORPORATION, Port Huron, Mich. Bulletin 423-YY, on "Colloidal Graphite as a High-Temperature Lubricant." ... 42

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FEDERAL PRODUCTS CORPORATION, 1144 Eddy St., Providence, R. I. Folder descriptive of the new Testmaster universal dial indicator. ... 43

Industrial Diamonds

J. K. SMIT & SONS, INC., 157 Chambers St., New York City. Booklet entitled "Diamonds in Industry," published monthly. ... 44

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RANSOME MACHINERY CO., Dunellen, N. J. Bulletin 196, on welding positioners of 2500 pounds capacity. ... 45

Precision Measuring Instruments

JANSSON GAGE CO., 19222 Glendale Ave., Detroit, Mich. Handbook on "Precision Measurement." ... 46

Zinc-Plated Steel

AMERICAN NICKELOID CO., Peru, Ill. Folder on zinc-plated steel. ... 47

To Obtain Additional Information on Shop Equipment

Which of the new or improved equipment described on pages 222-242 is likely to prove advantageous in your shop? To obtain additional information or catalogues about such equipment, fill in below the identifying number found at the end of each description—or write directly to the manufacturer, mentioning machine as described in July, 1943, MACHINERY.

No.	No.	No.	No.	No.	No.	No.	No.	No.	No.

Fill in your name and address on other side of this blank.

Detach and mail to MACHINERY, 148 Lafayette St., New York 13, N. Y.

[SEE OTHER SIDE]

Kirksite Cast Jaws Facilitate Machining Operations

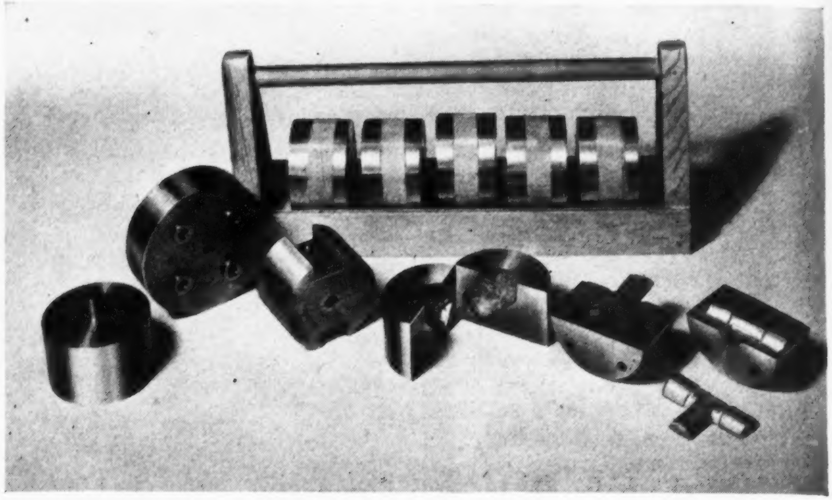


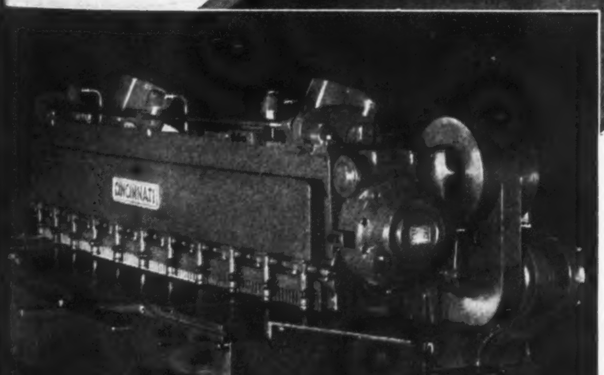
Fig. 1. Kirksite Jaws can be Cast around Unusual-shaped Pieces for Machining. At Lower Right are Jaws for Holding Hydraulic Fittings

IN the manufacture of hydraulic fittings, the American Screw Products, of Los Angeles, Calif., for a long time followed the practice of making jaws out of steel for holding the fittings in the machining operations. The production of these jaws in the tool-room was a slow and expensive process, and they were satisfactory only when produced by skilled workmen.

In an effort to comply with the War Production Board's request for greater production, experiments were conducted with a view to making these jaws from a commercial type of fusible alloy. The alloy was cast around the fittings, and after it had hardened was cut into two parts or jaws. The need for a harder and more durable material than this fusible alloy led to casting the jaws from the zinc-base alloy Kirksite A. This practice has effected great economy and speeded up production. Believing that a tremendous number of man-hours could be saved by the adoption of

Fig. 2. A Pair of Kirksite Jaws Applied to a Barker Wrenchless Chuck for Holding Right-angle Fittings while Turning, Boring, and Threading

Fig. 3. Another Pair of Kirksite Jaws Mounted in a Vise for Holding Right-angle Fittings for Operations on an Upright Drilling Machine



It's "Hammer and Tongs" on the production line for Victory on the battle line . . .

Tons of armor plate, tough alloy steel, tricky aluminum sheets for airplanes, tanks, ships, and equipment for our armed forces are sheared on Cincinnati All-Steel Shears.

A Cincinnati All-Steel Shear may "step-up" your production.

Write for recommendation and Catalog S-2

THE CINCINNATI SHAPER CO.

CINCINNATI OHIO U.S.A.

SHAPERS BRAKES SHEARS

this practice in other plants, the American Screw Products is offering engineering service and data freely to those interested.

The particular value of the practice lies in its universal adaptation to various types of clamping fixtures, chucks, over-size collets, and vises. The jaws can be used in multiple-spindle automatic chucking machines, wire-feed screw machines, turret lathes, vises, and so on.

Two sizes of jaws, 2 7/8 and 4 inches outside diameter, accommodate practically all of the forgings handled in the plant of American Screw Products. In sets of five pairs, these jaws can be used for long runs on automatic chucking machines. For a short run, any set can be mounted on two-jawed air chucks, Barker wrenchless chucks, or special over-sized collets. The jaws can also be mounted in an air-operated vise for operations on drilling machines.

Two sets of Kirksite jaws opened up are seen at the lower right in Fig. 1, and a closed set immediately to the left of the open pairs. The closed set has slots milled in opposite sides to adapt the jaws to two-jawed air chucks. Still further to the left is a jig employed in drilling four holes in the faces of jaws to be applied to over-size collets.

Fig. 2 shows Kirksite jaws mounted on a Barker wrenchless chuck for use on a lathe, and Fig. 3 shows another pair of these jaws set up in a vise for a drilling operation on right-angle fittings.

Operators and set-up men have been found to prefer Kirksite jaws to the machined type previously in use. The Kirksite jaws require no shimming or adjusting, and because they hold the forging over a large area of contact, enable superior work to be turned out. The jaws can be mounted quickly and the forging will run true. This feature makes it possible to allow only 1/16 inch of stock on diameters in turning fittings instead of the not uncommon allowance of 3/32 or 1/8 inch. A set of Kirksite jaws has been used for from 8000 to 10,000 operations without loss of accuracy, which means that their life is much longer than that.

Repairing Worn Ways on Engine Lathes by Metallizing

By C. A. SHAFFER, General Machinery Supervisor
Illinois Central Railroad Co., Chicago, Ill.

SHORTLY before Pearl Harbor, when a shortage of new machine tools already was being experienced, the Illinois Central System made an effort to repair and make available for service all old and unused equipment in its shops. At this time, an engine lathe that had been retired from service was inspected to determine its proper disposition.

The general condition of the lathe unquestionably warranted repairs, but in addition to work necessary on the headstock and clutch mechanism, it was found that the carriage ways on the bed were worn hollow for a length of about 7 feet and to an approximate depth of 1/32 inch at the lowest point. Having no planer available on which to replane the lathe bed, consideration was given to other means of restoring the ways. We had never heard of metallizing being used for this purpose, but it seemed feasible and worth trying.

A local metallizing concern—Metallizing, Inc. —that had done some of our other work was asked for an opinion. The experience of the firm had not covered this type of work, but the company offered to do the metallizing practically at cost, in order to determine its merit. Accordingly, an order was placed with them for a job considered more or less of an experiment.

Old Method of Repair

The old or conventional method of correcting worn ways is to disassemble the machine or at least remove all units from the lathe bed, in order to remachine the ways and top surface of the bed in a planer. Owing to the fact that the top bed surface is lowered by this method, it is necessary to compensate for the depth of metal removed by relocating the lead-screw and feed-shaft nut and clutch units in the carriage apron, and possibly make some other similar correction because of the alteration in the original height of the bed. A complete job of this kind requires from 120 to 260 man-hours. The average cost, including labor and machinery, is around $200.

In planning to do this work by metallizing, some tests were first made. A test piece 18 inches long, of cast iron like that in the lathe

AIRCRAFT

LANDING GEAR STRUTS

Large scale production of Aircraft Landing Gear Struts includes a number of intricate operations — one of which is illustrated below. This job is performed at the plant of the Axelson Manufacturing Co., and employs the Super Service Radial to drill holes in forgings for end fittings at the exact angle in respect to the center line of the work. Precision locating, plus the precision-performance of the Super Service Radial results in the production efficiency so essential to the maintenance of a high output rate. Detailed information on the wartime performance possibilities of the Super Service Radial upon request.

ARMY E NAVY AWARDED SEPT 10, 1942

THE CINCINNATI BICKFORD TOOL CO.

OAKLEY, CINCINNATI, OHIO

bed, was machined to the same shape and dimensions as a cross-section of the lathe ways. To this was applied a coating of a recommended hard steel. The test piece was then subjected to abuse, such as pressure, shock, and attempted chipping with a hand chisel. Since the test piece was found very satisfactory, the actual work on the machine was carried out.

Preparation for Metallizing

The hollow worn portion of the side slopes on the ways was chipped out full length to an equal depth, so that there would not be a feather-edge run-out of sprayed metal; also, the ends of the chipped surfaces were bevel-under-cut. The chipping was done with pneumatic hammers and a flat chisel, after which the chipped surface was gouged in different directions with a small, sharp-nosed hand tool similar to a diamond-point chisel. This was followed by a knurling or rough-rolling operation to afford adhesion of the sprayed metal. The surface was also slightly sand-blasted in order to remove any oil or grease. Adjacent surfaces were protected by masking.

About 10 to 12 pounds of hard steel wire was used, including necessary wastage. The deposit averaged 1/16 inch in depth, and left an almost file-hard surface, which required grinding for a finishing operation. During the metallizing operation, a 10-foot straightedge was used at frequent intervals to check the height of the material applied and to keep it at a reasonable level (from 1/64 to 1/32 inch) above the original surface for subsequent grinding.

Finishing the Surface by Grinding

The finishing or grinding operation was simplified and expedited by using the lathe tailstock base on the unworn part of the way as a traversing carrier and guide for the grinder. The body or upper section of the tailstock was removed from the base, and to the latter was bolted an adjustable swiveling adapter toolpost in which a portable pneumatic angle type grinder was clamped.

A 5-inch coarse-grained cup-shaped abrasive wheel was used first, and a finer grained wheel for the finishing. When the face of the grinding wheel was set to the exact angle or slope of the way, the grinder was fed back and forth by operating the crank-handle of the tailstock manually. In this manner, both sides or slopes of the metallized portion of the carriage ways were ground flush with the unworn surface. The final finish was all that could be desired, and required no additional hand work.

Owing to the circumstances under which this job was done, it was not possible to keep an accurate record of time and costs. However, the following estimate is a close approximation:

Preparation: 24 man-hours	$25
Metallizing: Labor and material	35
Finishing and assembly: 30 man-hours	35
Total	$95

No unusual procedures were employed in this work, except perhaps for the utilization of the tailstock, this being used first to rough-knurl the surface during preparation and later for carrying the grinder to produce a straight finish in true alignment with the original surface.

Judging from the appearance of the hard steel metallized surface after more than a year's service, it should outlast the original cast iron. Under the circumstances and conditions explained, the metallizing method is considered advantageous because of its convenience, lower cost, and probably longer life, and because it minimizes the "time out" for the machine. While the job described was the first of its kind in this shop, the results obtained seem to warrant the use of metallizing on other types of machine tools besides lathes.

Most of our other applications of metallizing have been confined to circular work, such as rotating shaft bearings. Probably our most important applications so far have been the restoring of worn and scored crankshaft bearings, particularly for large Diesel engines, because of the longer service obtained at low cost, compared with replacements.

* * *

New Army-Navy "E" Awards

The Army-Navy "E" Award has been presented to the following concerns in the machine-building and allied industries for excellence in production:

American Locomotive Co., (Latrobe Plant), Latrobe, Pa.

Lombard Governor Corporation, Ashland, Mass.

Republic Aircraft Products Division of the Aviation Corporation, Detroit, Mich.

Republic Drill & Tool Co., Chicago, Ill.

Rockford Drilling Machine Division of Borg-Warner Corporation, Rockford, Ill.

Sullivan Machinery Co., Michigan City, Ind.

United Welding Co., Middletown, Ohio.

* * *

You cannot help the poor by destroying the prosperous, nor can you lift the wage-earner to a higher level by pulling down the wage-payer to a lower plane.

PRECISION *Thread Grinding*

. . . the modern method of producing accurate threads

Precision thread grinding has already become a vital step in the accelerated production of accurate threaded parts by American industry. Many manufacturers of parts for war material are grinding threads with Ex-Cell-O Precision Thread Grinders after the threaded parts are hardened, or grinding threads from the solid after heat treatment, because only by this method can they obtain uniformly, a high standard of accuracy in thread form, size, and finish. . . . With an Ex-Cell-O Precision Thread Grinder, you, too, can produce accurately ground threads on a profitable production basis. You can not only take advantage of today's great demand for precision threaded parts, but also provide for the future, when the precision grinding of all threaded parts in which accuracy is essential will undoubtedly be required.

EX-CELL-O CORPORATION • DETROIT

To the left: Ex-Cell-O Style 31 Precision Thread Grinder (this is one of nine styles of Ex-Cell-O precision thread grinding machines).

Precision THREAD GRINDING, BORING AND LAPPING MACHINES • TOOL GRINDERS • HYDRAULIC POWER UNITS • GRINDING SPINDLES • BROACHES • CONTINENTAL CUTTING TOOLS • DRILL JIG BUSHINGS • DIESEL FUEL INJECTION EQUIPMENT PURE-PAK CONTAINER MACHINES • R. R. PINS AND BUSHINGS • PRECISION PARTS

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EX-CELL-O *for* PRECISION

Shop Equipment News

Machine Tools, Unit Mechanisms, Machine Parts, and Material-Handling Appliances Recently Placed on the Market

Gorton Precision Automatic Screw Machine

A precision automatic screw machine, adapted for the mass production of a wide variety of extremely accurate small parts ranging from 0.005 to 7/16 inch in diameter and from 1/32 inch to 2 3/4 inches in length, has just been added to the line of precision machine tools manufactured by the George Gorton Machine Co., 1316 Racine St., Racine, Wis. This machine, designated the Gorton 16-A, is an American development of the well-known Swiss Petermann P-7 automatic screw machine for which the Gorton company has been granted exclusive manufacturing rights in the United States by Joseph Petermann, Moutier, Switzerland.

Recent developments designed to obtain greater accuracy and higher production have been incorporated in the new 16-A machine. All tool equipment, vital parts, and attachments of the Gorton 16-A and the Petermann P-7 machines are interchangeable.

An almost endless variety of parts of simple and complex design can be automatically produced in one operation on the Gorton 16-A machine, which is particularly adapted to turning pinions, shafts, screws, and small slender parts used in clocks, meters, radio equipment, precision instruments, guns, and aircraft engines. In addition to step and contour turning and chamfering, the machine, with attachments, will automatically perform centering, drilling, threading, and slotting operations.

The stock from which the parts are to be made is fed to the five-station multiple tool-head by means of a cam. The feeding movement pushes the stock through a close fitting bushing past the cutting tools, which are stationary in the horizontal plane. Thus, the work is supported at the point where it receives the side thrust of the tools. This arrangement makes it possible to produce parts to extremely close limits of accuracy with respect to diameter dimensions, and also enables a high finish to be obtained.

The five tools in the multiple tool-head are adjustable radially and axially by means of micrometer screws with 0.0005-inch graduations. The holders for these tools are hardened, and will accommodate any size tools up to 5/16 inch square. The two lower tool-slides are mounted on a rocker arm which has a 3-to-1 cam-actuated movement. The tools in these slides are generally used for turning the most important diameters because of the rigidity of the rocker assembly, which is mounted on a radial ball bearing with a Timken end-thrust bearing. The cam-to-work ratio of the other three tool-slides is variable from 2 to 1 up to 3 to 1.

The dynamically balanced spindle, enclosed in a semi-nickel steel headstock which is mounted on a scraped and gibbed slide on the bed, is driven by a flat, endless woven belt. This drive is especially designed to eliminate tool marks on the work. The bar stock is held in the spindle collet and fed through the guide bushing to the tools by feeding the headstock forward as a unit. Synchronizing this longitudinal cam movement with cams that control the lateral movement of the tools permits generating tapers and forms of almost any desired shape with single-point tools.

Fig. 1. Gorton Precision Automatic Screw Machine

To obtain additional information on equipment described on this page, see lower part of page 214.

"Ploughing" through tough cast armor plate at cuts up to 1 in. deep—drilling gun barrels—cutting off shell—taking interrupted cuts through sand holes and scale—producing a quality of finish on critical parts often impossible to obtain with former tools—holding close tolerances that drastically reduce and often entirely eliminate subsequent grinding—making steels of 400 to 500 Brinell machineable—these are typical of the present day uses of Carboloy cemented carbide tools for cutting steel.

Today 63% of all Carboloy cemented carbides produced by Carboloy Company for machining applications are steel cutting grades. You'll find them in practically every major war plant throughout the nation, turning out steel parts for war at speeds 4 to 5 times faster than former tool materials, staying sharp up to 10 times longer—increasing production often as much as 300% on the thousands of applications upon which victory depends.

Write today for catalog GT-142 listing Carboloy cemented carbide grades for cutting steel, cast iron and non-ferrous metals available in more than 300 standard Carboloy tools and blanks.

Are You Using The Right Chip Breaker?

A special film available on design and grinding of chip breakers for carbide tools. One of a series of six films on Design, Brazing, Application and Grinding of carbide tools for use in your training program. Write for folder GT-151.

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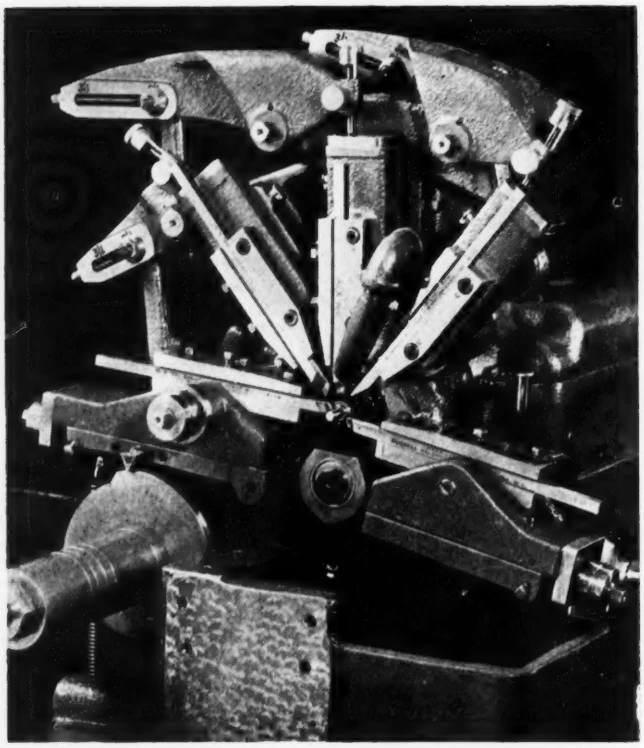
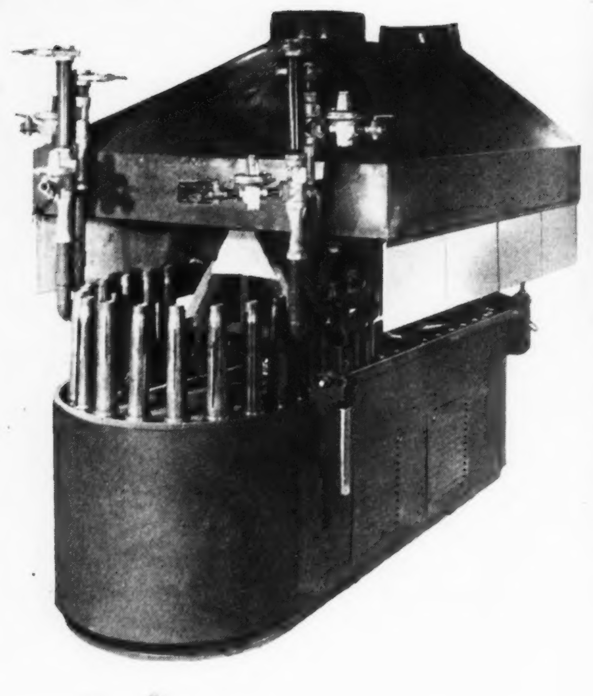


Fig. 2. Close-up View of Tool Set-up on Gorton Precision Automatic Screw Machine Illustrated in Fig. 1



Morrison Annealing Machine Equipped with Rotating Work-holders for Annealing 57-mm. Cartridge Cases

All cams are mounted on a single shaft at the rear of the machine, where they are easily accessible for adjustment or change in set-up. A handwheel provides means for disengaging the camshaft drive and for manual control during setting-up operations. Electrical interlocks prevent camshaft motion when the spindle is not turning, thus eliminating tool breakage. Spindle speeds can be changed instantly by turning the regulator wheel. Camshaft speeds are also controlled by a regulator wheel while the machine is running.

Any spindle speed from 1100 to 10,000 R.P.M. is provided by the Reeves variable-speed drive and the two-speed 2-H.P. or 1 1/3-H.P. motor. The low-range camshaft-speed control dial permits adjustments for producing from 20 to 720 pieces per hour, while the high-range control dial can be adjusted for producing from 20 to 1440 pieces per hour. Any combination of feeds and speeds can be employed as required for machining tough alloy steels and the softer non-ferrous materials. The camshaft is driven by a 1/3-H.P. motor.

A gear type coolant pump and a 1/4-H.P. motor, mounted as a unit in a compartment at the rear of the machine, delivers coolant from a twelve-gallon reservoir. A weight-operated bar feed is regularly furnished, but a pneumatic feed is available. Three spindle attachments for centering, drilling, and threading operations can be provided. Threading spindles operating on a speed differential system eliminate the necessity of stopping the work-spindle. A slotting attachment can be had which automatically picks up the cut-off piece, slots it, and drops it into the work-discharge chute. A built-in automatic counter registers the number of pieces produced. The complete machine weighs 3000 pounds......51

Harnischfeger Alternating-Current Electrodes

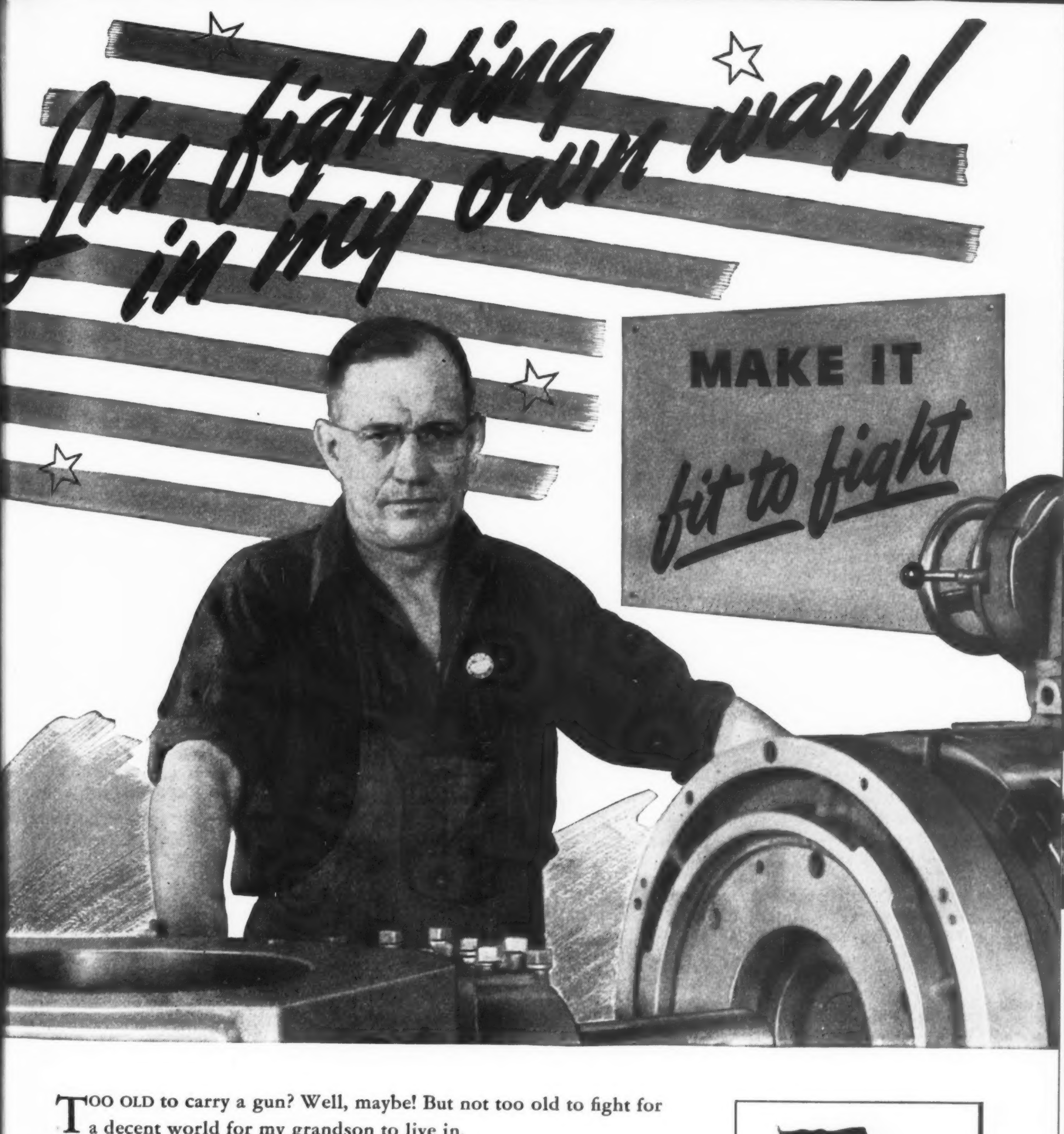
Coincident with the recent announcement of a new line of P&H alternating-current arc welders, the Harnischfeger Corporation, Milwaukee, Wis., has introduced an electrode designed especially for use with alternating-current transformer welding machines. This electrode is suited for all mild steel applications. It is made in the usual sizes of from 1/8 to 5/16 inch in diameter and in 14- and 18-inch lengths. The electrodes are packed in regular 50-pound containers. 52

Annealing Machine for Steel Cartridge Cases

The Morrison Engineering Co., Cleveland, Ohio, has developed a line of flame type annealing machines designed for rapid, efficient mouth and body annealing of cartridge cases in sizes ranging from 37 millimeters up to 105 millimeters. This equipment is built to produce a uniform anneal before the tapering operation is performed, and it can also be used for the final mouth annealing.

The machines are adapted for continuous operation. The production rate, which is arranged to suit the plant lay-out, ranges from 400 to 2000 cases per hour. A steel conveyor chain, driven by a variable-speed drive, provides means for passing the shells through the annealing chamber. This chain carries double-row ball-bearing mounted spindles on the tops of which are bolted work-holder adapters. The adapters are interchangeable for different sized cartridge cases. The burner equipment is of the blast-line type with zero governors and proportional mixers for each burner. Manometers are also provided for each burner to facilitate duplicating the burner adjustments that have been found satis-

To obtain additional information on equipment described on this page, see lower part of page 214.

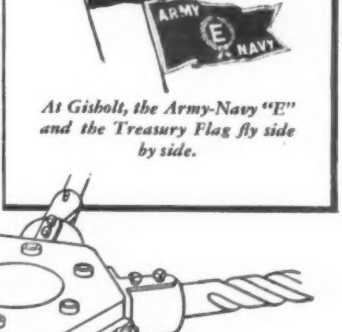


TOO OLD to carry a gun? Well, maybe! But not too old to fight for a decent world for my grandson to live in.

I fight with the weapons America understands best—machine tools, mass production—interchangeable parts!

I make this part over and over again. It's always the same—always accurate, so that on assembly line or in the repair shop, the parts always fit—precisely!

My Gisholt and I will keep at it—making parts that are *fit to fight*—until the last shot has been fired.



At Gisholt, the Army-Navy "E" and the Treasury Flag fly side by side.

GISHOLT MACHINE COMPANY
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TURRET LATHES • AUTOMATIC LATHES • BALANCING MACHINES

factory. By operating at comparatively high mixture pressures and by rotating the work from 60 to 100 R.P.M. in front of the burners, extremely fast heating is obtained.

Loading and unloading is a continuous manual operation at one end of the machine. A sheet-metal hood with vent connection encloses the operating mechanisms. The machine adapted for annealing 105-millimeter cases requires a floor space of only 3 1/2 by 10 feet. Each machine is shipped as a complete unit, including combustion blower with all necessary motors and starters. 53

Cincinnati Radius-Grinding Attachment

A radius-grinding attachment has been designed by the Cincinnati Milling Machine Co., Cincinnati, Ohio, especially for use on the Cincinnati No. 2 cutter and tool grinder. It is designated "No. 1 size" to differentiate it from a similar attachment for grinding face mills.

A wide range of cutters can be ground with this new unit, which is designed for the grinding of ball-end and die-sinking cutters. With the addition of accessory equipment, other types of work can also be handled, such as the grinding of double-end cutters with straight or helical flutes and the cylindrical grinding of die-sinking tracer fingers.

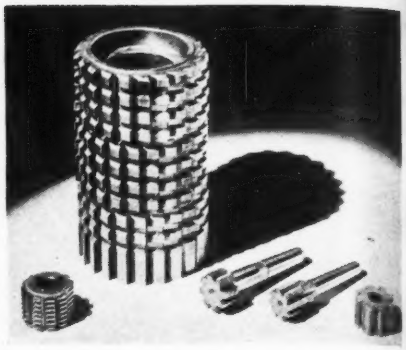
The attachment has two slides, each providing longitudinal and transverse adjustment of the work with respect to the grinding wheel. An anti-friction pivot bearing in the base insures a smooth, uniform swiveling motion, and enables the slides to swivel through an angle of 360 degrees. Movable stops have screw adjustments which accurately limit the swivel motion.

The index-plate at the rear of the work-head spindle has twenty-four notches in it. With this device, the attachment will handle straight flutes or cutters having one, two, three, four, six, eight, twelve, and twenty-four flutes without the necessity of employing a tool-rest. In grinding cutters with helical flutes, the universal tool-rest supplied with the machine is used.

A feature of the collet equipment is a unique stop-collar which enables the operator to quickly remove small cutters under 1 1/2 inches in diameter for inspection. When replaced for additional grinding, the cutters are located in exactly their previous positions. The attachment has a capacity for grinding ball-end cutters 3 inches in diameter and taper work held in spindles in sizes up to No. 5 Morse. The weight of the attachment is approximately 98 pounds. 54

Plan-O-Mill Multiple Thread Milling Cutters

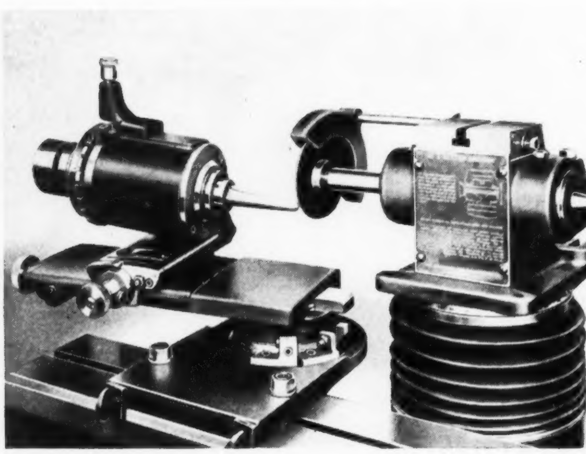
The Plan-O-Mill Corporation, 1511 E. Eight Mile Road, Hazel Park, Mich., manufacturer of planetary milling machines, has brought out a line of multiple thread milling cutters for cutting National, Whitworth, Acme, vee, and special form threads. These cutters are furnished either ground or unground for use on any type of thread milling machine. They have been designed to incorporate features developed as a result of experience gained in the manufacture of Plan-O-Mill machines for threading a wide variety of parts. The cutters are available with straight or spiral flutes in a complete range of sizes. 55



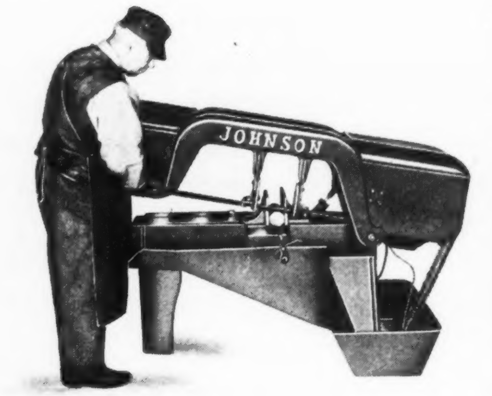
Plan-O-Mill Multiple Thread Milling Cutters

Johnson Metal Saw Equipped for Wet Cutting

The Johnson Mfg. Corporation, Chrysler Bldg., 405 Lexington Ave., New York City, has brought out a high-speed metal-cutting saw equipped with a coolant tank and pump for wet cutting operations. The coolant pump is of the non-clogging piston type, driven by a noiseless cam arrangement. The speed of the pump is automatically



Radius-grinding Attachment for Cincinnati Tool and Cutter Grinder



High-speed Metal-cutting Saw Made by the Johnson Mfg. Corporation

To obtain additional information on equipment described on this page, see lower part of page 214.

regulated by the speed of the saw, so that the flow of coolant suits the speed of the saw blade. If dry cutting is desired, the pump can be readily disconnected. Saws previously made by this company can easily be fitted with the new coolant equipment. 56

Quick-Opening Mechanism for Lanco Die-Heads

In cutting threads to close tolerances it is sometimes necessary to have the head open instantaneously, so that the length of travel of the carriage ordinarily required for opening the head will not affect the lead or pitch diameter of the work. A mechanism for imparting this opening action to the 7V Lanco hardened and ground head applied to the Landis standard bolt threading machine has been developed by engineers of the Landis Machine Co., Waynesboro, Pa.

The mechanism comprises a spring used in combination with a latch and a latch block arrangement, in addition to the conventional yoke employed to open and close the head. In operation, the yoke is employed to close and latch the head within itself. When the head is in the closed position the yoke also locks independently of the die-head.

As the yoke closes the head, spring tension is built up in the extension spring, one end of which is anchored to the machine bed, while the other end is attached to the yoke. As the threading operation progresses to the point where the die-head is to be opened, a sleeve on the trip-rod raises the latch, thus releasing the yoke and permitting it to snap back quickly, so that the head opens instantly.

The mechanism is adjustable for threads of different lengths by moving the latch operating sleeve on the trip-rod and by moving the latch block bracket along the ways of the machine. Means are also provided for adjusting the tension of the spring. The quick-opening mechanism can be applied to Landis 7/8-inch single- or double-head threading machines already in service. 57

Safety Goggle Made for Women Workers

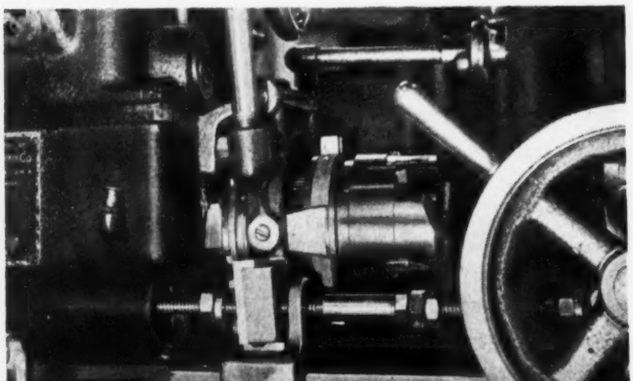
"Ful-Vue" Safety Goggle

A new "Ful-Vue" safety goggle with curved clear "Super Armorplate" lenses, designed to protect the eyes of women industrial workers, has been placed on the market by the American Optical Co., Southbridge, Mass. This goggle is specifically designed to fit the smaller features of women. It is made in 42-millimeter eye size, and is available in three bridge sizes of 19, 21, and 23 millimeters to combine efficient eye protection against flying objects with the greatest degree of all-around visibility, comfort, and appearance. 58

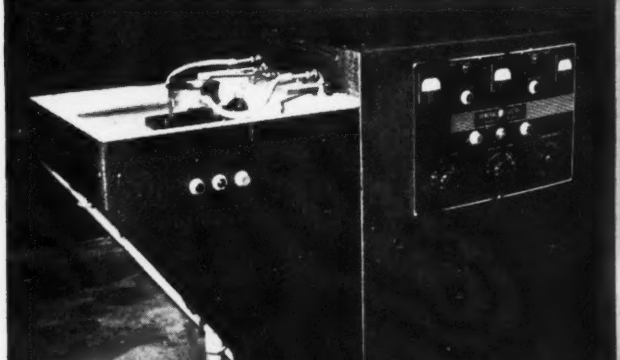
Electronic Heaters for Brazing, Soldering, and Heat-Treating Operations

A line of electronic heaters for the high-frequency induction heating of metal parts for brazing, soldering, and selective heat-treating has been brought out by the Industrial Heating Division of the General Electric Co., Schenectady, N. Y. These new heaters are essentially power oscillators, which convert 60-cycle power to high-frequency power at approximately 500,000 cycles. They are available in two standard sizes, one having an output of 5 kilowatts, and the other 15 kilowatts.

Conservatively rated elements are used to reduce maintenance requirements to the periodical replacement of tubes, which have an average life expectancy of 5000 to 10,000 hours or more. Attached to the electronic heater is a suitable



Lanco Die-head Equipped with Quick-opening Mechanism



Electronic Heater for Brazing, Soldering, and Heat-treating

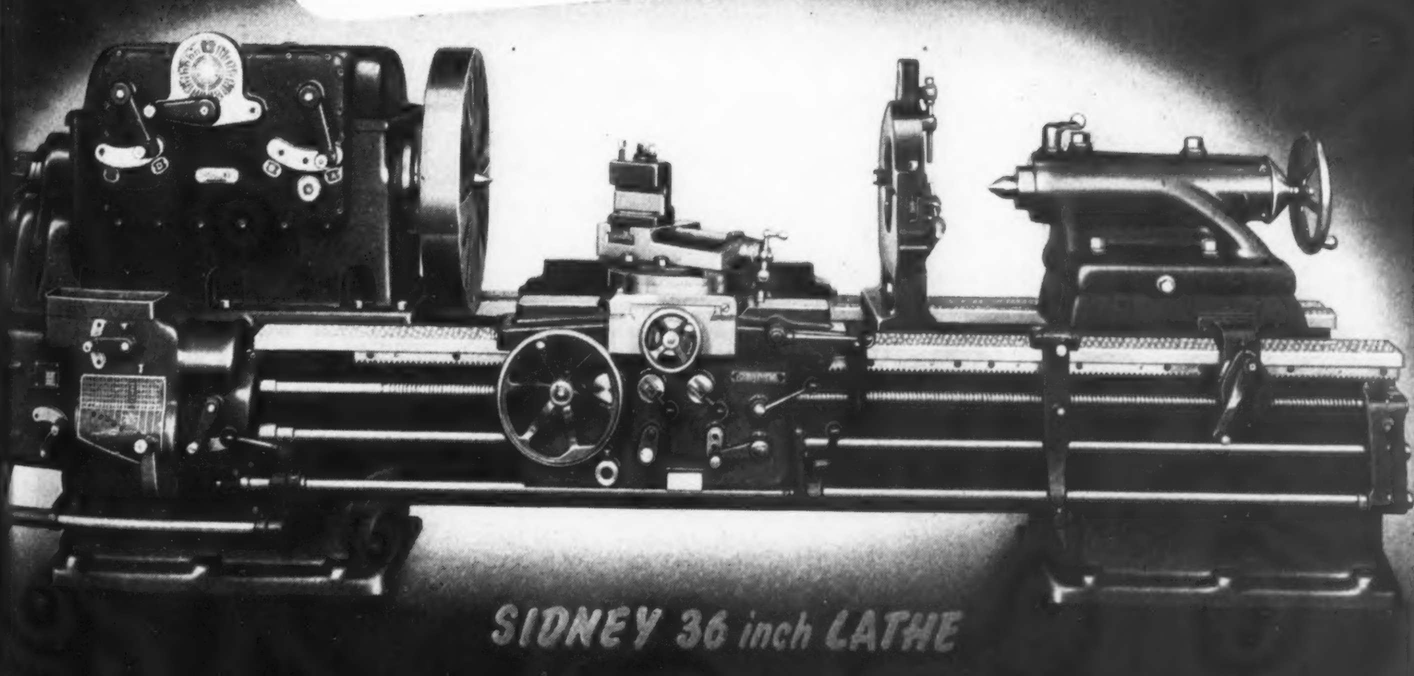
To obtain additional information on equipment described on this page, see lower part of page 214.

Sidney Lathes

● The lathes today that will stand the strain of "round-the-clock" production—maintain accuracy—keep needed production flowing to our many fronts are the lathes that will be selected for our future output when costs will take a more prominent place in production plans.

Sidney Lathes operating in airplane plants—Shipyards—munitions plants—tank and industrial plants are meeting the test of urgent war production.

The 36 inch Sidney Lathe shown is designed and built to give the utmost of production—the greatest possible versatility—and long, trouble-free life. Massively built, 16 speed continuous tooth herringbone geared head and versatile gear unit are a few of the many points of Sidney construction that make for greater production—dependable accuracy—and longer, care-free life.



SIDNEY 36 inch LATHE

The SIDNEY MACHINE TOOL Company

Builders of Precision Machinery

SIDNEY — ESTABLISHED 1904 — OHIO

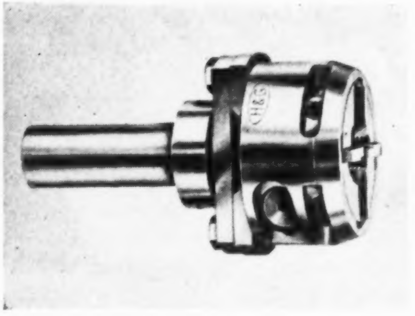
work-table with the necessary water-cooled coil or coils connected to the heater terminals. The coils can be fabricated easily in different shapes, as required for the work to be done.

With the inductor coil connected to the terminals and the oscillator and the controls properly set, the required heating operation can be repeated by simply locating the work in the inductor coil and starting the automatic cycle by operating a push-button.

Among the more important advantages claimed for the new electronic heaters are the following: Heating easily confined to the desired area; heating operations can be performed by unskilled worker after heater is adjusted; heat distribution accurately and automatically controlled; and conservation of critical alloy steels. 59

Solid Adjustable Die-Heads for Automatic Screw Machines

A solid adjustable die-head, known as Style SAML, is being made in five sizes by the Eastern Machine Screw Corporation, 23-43 Barclay St., New Haven, Conn., to suit all sizes of Brown & Sharpe automatic screw machines. These



Die-head for Automatic Screw Machines, Made by the Eastern Machine Screw Corporation

die-heads are provided with the same insert chasers as are used in the corresponding sizes of H & G insert-chaser self-opening die-heads.

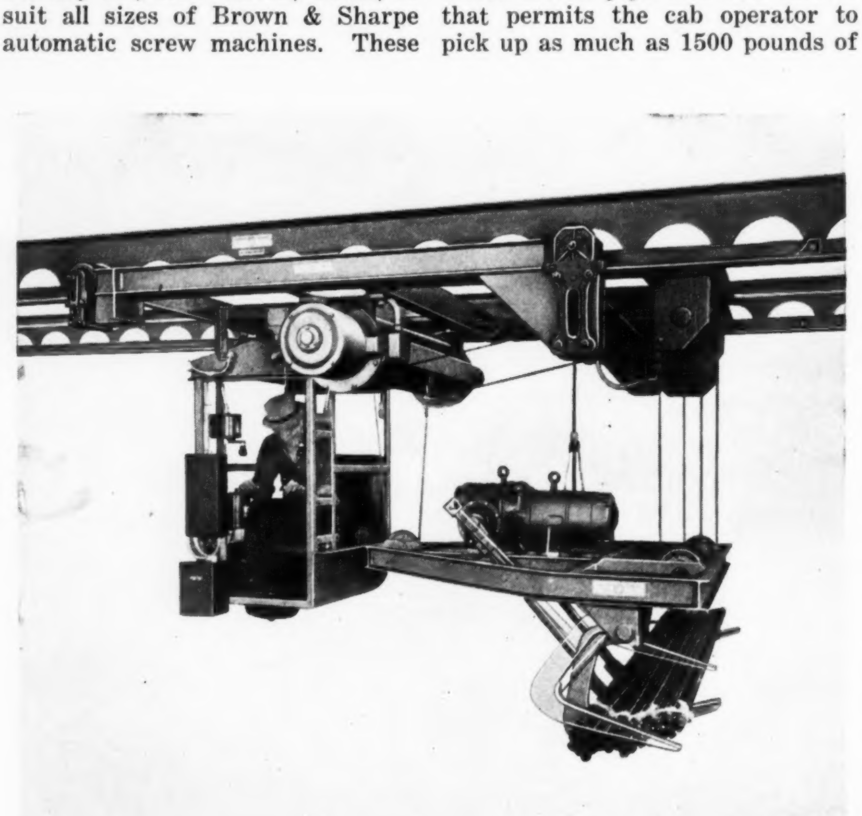
The No. 00 size head has a range of 0 to 3/8 inch, and is designed for use on the No. 00 B & S automatic. The 0 to 1/2-inch and 17/32- to 3/4-inch sizes are designed for use on the No. 0 B & S automatic, while the 25/32- to 1-inch and the 1 1/32- to 1 1/4-inch sizes are designed for the No. 2 B & S automatic.

The heads can be used on larger machines than those indicated by employing bushings for the shanks. These heads are complete with holders, and are provided with an alignment feature to compensate for misalignment of turret and spindle. The chasers can be easily removed for grinding, and have cut threads on 30,000 stainless-steel screws without resharpening.

These die-heads are extremely light in weight, relatively small in diameter, and of short length. The light weight is said to add materially to chaser life and thread quality. Since these heads have no moving parts, there is practically nothing to get out of order. They are adjustable for size. 60

Motor-Driven Pipe and Rod Carrier

The Cleveland Tramrail Division of the Cleveland Crane & Engineering Co., 1157 E. 283rd St., Wickliffe, Ohio, has brought out a new motor-driven pipe and rod carrier that permits the cab operator to pick up as much as 1500 pounds of stock in 12-foot lengths from the storage room, transport it, and set it in racks at fabricating machines without the services of men on the floor. Since the unit travels overhead, its use eliminates the need for aisles and makes possible the saving of considerable floor space.



Cleveland Overhead Carrier with Cab Control for Pipe and Rod

With this equipment, loads can be swiftly moved above machines and men. The materials transported need not be in balance nor is it necessary for the operator to spend time in locating the center of gravity of the load. The pick-up fork assembly has a three-point rope suspension from the carrier, which gives it the necessary rigidity for handling loads that are considerably out of balance. Another factor in providing stability is the double overhead track system on which the carrier travels. This minimizes swing and prevents the loads from slipping or falling in transit.

Rod and pipe are handled by two forks, which are tilted upward when loading and downward when unloading by a motor-driven crank. A limit switch automatically stops the forks in the upward or holding position when the mechanism is not in operation. The fork assembly can be raised or lowered as required. The unit shown has a lift of 8 feet, but others can be furnished for lifts of 20 feet or more

To obtain additional information on equipment described on this page, see lower part of page 214

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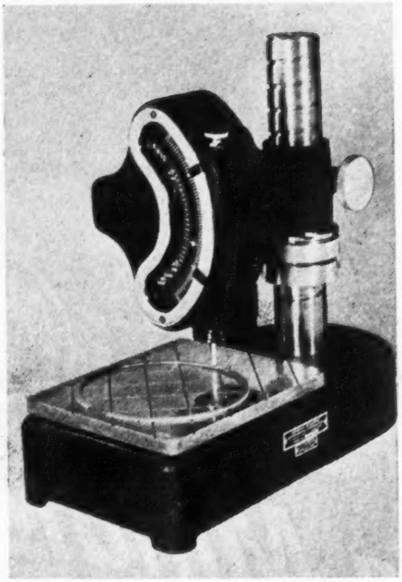
if required. The hoisting speed is 20 feet per minute, and the carrier travel speed is 300 feet per minute. Similar carriers can be supplied for heavier loads and for materials of various lengths. 61

"Amic" Precision Indicating Gage for Piston-Rings

The American Measuring Instruments Corporation, 240 W. 40th St., New York City, has recently added to its line of Amic gages a precision indicating instrument designed especially for use in gaging piston-rings for airplane engines. This instrument has a parallel-ground, lapped and serrated table, 6 1/2 by 8 inches, for use in measuring the width of piston-rings and other components of large area. The column has one coarse and one fine adjustment for setting the comparator by means of a master gage or gage-blocks. Precision setting is obtained by a final adjustment of the dial. Two limit hands indicate the range of tolerance requirements.

The magnification ratio is 1 to 1000, a displacement of the measuring pin of 0.001 inch causing the indicating hand to move 1 inch on the 6-inch dial, which is graduated to read in both inches and millimeters. Each inch space on the dial is divided into tenths. Deviations as small as 0.00002 can be detected with ease. The measuring capacity is plus or minus 0.003 inch and plus or minus 0.05 millimeter.

A lever on the outside of the housing permits lifting the measuring pin before inserting the piece to be measured. For special applications, accessories such as thread measuring devices, ball anvils, V-blocks, centering fixtures, and various types of back-stops can be supplied. 62



"Amic" Precision Gage for Measuring Piston-rings

Huge Micromatic Honing Tool

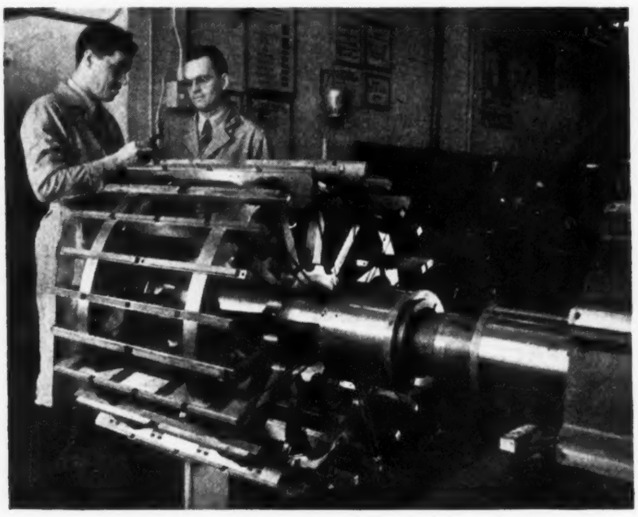
A hone abrading tool that is believed to be the largest in the world was recently completed by the Micromatic Hone Corporation, 8100 Schoolcraft St., Detroit, Mich., for use in a special horizontal honing machine designed and built by the Barnes Drill Co., Rockford, Ill. This huge hydraulically controlled hone is 41 1/2 inches in diameter by approximately 63 feet long over all, and weighs approximately 6500 pounds. It is intended for use in a bore 40 feet long from which it is expected to remove approximately 1/16 inch of stock on the diameter to clean up the bore. This involves removal of approximately 1990 cubic inches of metal, or more than 550 pounds of metal, by the hone abrading process. ..63

Ransome Welding Positioner

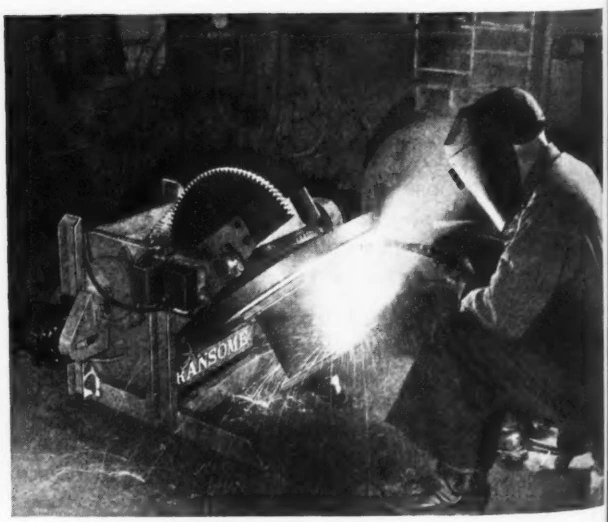
A welding positioner designed to handle work up to 500 pounds in weight with the center of gravity of the load 6 inches from the table top and 6 inches off center has been brought out by the Ransome Machinery Co., Dunellen, N. J. This new positioner is available in hand- or motor-operated models, and is particularly suited to work ordinarily handled by women.

The motorized unit includes a Reeves variable-speed drive for rotating the table top at any desired speed up to 1 R.P.M. The tilting range is a full 135 degrees from the horizontal or 45 degrees from the vertical position. This adjustment provides the "down under" position required for all "downhand" welds.

The circular table top is 2[illegible] inches in diameter, and has T-slots for clamping the work. All gears are of the cut-tooth type. The machine can be furnished with a reg-



Micromatic Honing Tool for Finishing Bore 40 Feet Long by 41 1/2 Inches Diameter



Welding Positioner of 500 Pounds Capacity, Brought out by the Ransome Machinery Co.

To obtain additional information on equipment described on this page, see lower part of page 214

STRONG ARM OF THE FLEET

TO THROW an airplane into the air takes a mighty strong arm. Launching these eyes of the fleet from a cruiser deck is the job of the catapult.

Gears on the catapult must be rugged to stand the punishing shock that comes when the speed of the airplane weighing more than two tons is increased from 0 to 70 miles per hour in a distance of 60 feet!

The gears in the engines powering these planes must be tough, too. For though light in weight, their job is to transmit the power of 2000 horses to whirling propeller blades.

Making these gears—the rugged ones for the launching devices and the marvels of high precision for the airplane engines—is Foote Bros.' job, and Foote Bros. are proud of the service that the gears they make are rendering—proud of the manufacturing know-hows, the advancements in techniques that have been developed to produce these gears in the tremendous quantities needed for an America at war.

But more important to American Industry is what these manufacturing know-hows will mean to peacetime production. For experience gained today in producing gears that are tougher—gears that possess a higher degree of precision—gears that demand the latest manufacturing technique will assure more economical power transmission—more efficient machines for American Industry when the war is won.

FOOTE BROS. GEAR AND MACHINE CORPORATION
5225 South Western Boulevard • Chicago, Illinois

ARMY E NAVY

FOOTE BROS.

Better Power Transmission Through Better Gears

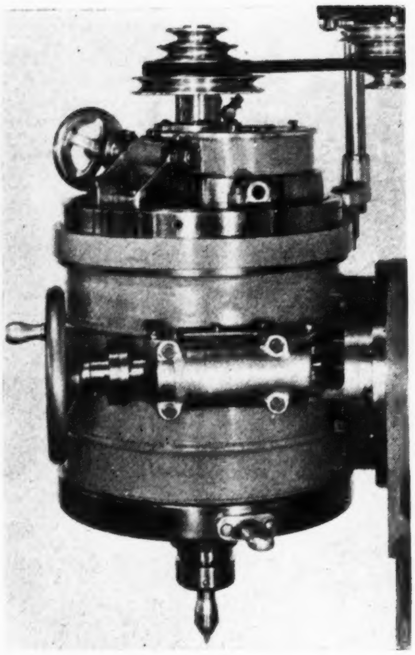
ular base for bench work or with a sub-base which gives it a height adjustment of 27 to 42 inches from the floor line to the table top. A clutch arrangement permits free rotation of the table top by hand. The motorized unit can be supplied with a handwheel in place of a motor for tilting if desired.......64

Harnischfeger Alternating-Current Welders

With a view to expanding its welding equipment service to war industries, the Harnischfeger Corporation, Milwaukee, Wis., has added a complete line of industrial alternating-current arc welders to its line of P & H direct-current machines. These new machines, built for industrial service, are being made in seven heavy-duty and four intermittent-duty models, with a wide range of capacities.

The new line features the recently adopted WSR (Welding Service Range) ratings, which show the actual minimum to maximum output of usable welding current. The WSR ratings of the heavy-duty models range from 50 to 270 amperes for the smallest size up to 200 to 1200 amperes for the largest size. The range of the intermittent-duty models is from 20 to 185 amperes up to 20 to 335 amperes. The setting and controlling of the current throughout the complete welding service range involve one simple adjustment.......65

Harnischfeger Alternating-current Welding Machine


Matthew Rotary Tool-carrier Milling Attachment

Matthew Rotary Tool-Carrier

A rotary tool-carrier designed to handle a complete multiple milling job in one setting of the work on the machine table has been brought out by the Production Machinery Development Co., 4845 St. Aubin Ave., Detroit, Mich. This patented attachment, with tool-carrying spindle, can be used with a fast direct feed or with a worm and wheel feed.

The attachment consists of three main parts—a stationary outside housing by which the head is fastened to the machine proper; a large inner body, fitted into the outer housing, which is equipped with a worm ring for rotation; and a smaller housing, known as the spindle-carrier unit, which is fitted to the large inner body with an accurately scraped bearing eccentrically located in the inner body.

The worm and handwheel assembly on top of the housing is used for setting the spindle for a circular movement of the desired radius or diameter. A worm and handwheel assembly is also provided for rotating the cutter-spindle, provision being made for disengaging the hand feed when rapid spindle movement is required. Collars on both assemblies are graduated in degrees and minutes.

A special milling machine with a maximum throat clearance of 32 inches is available for use with the rotary tool-carrier. The ram on the gibbed column of this machine has a travel of 26 inches. The table is 18 by 48 by 2 1/4 inches, and can be tilted toward and away from the machine column to any angle up to 30 degrees. The table has a longitudinal hand movement of 30 inches, a transverse movement of 16 inches, and a vertical adjustment of 24 inches. The machine weighs approximately 3800 pounds, and requires a floor space of 90 by 105 inches.......66

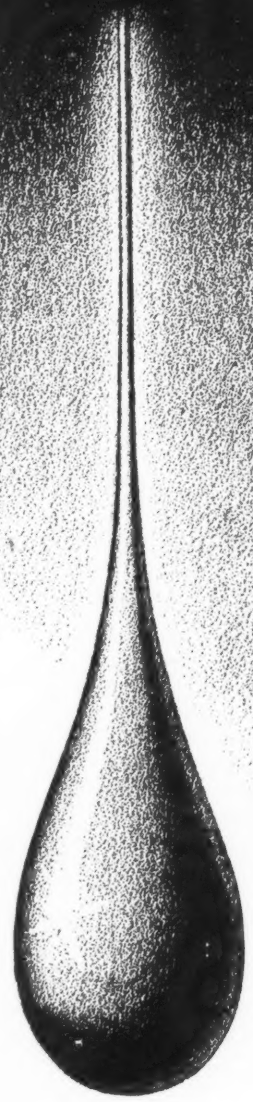
Universal "Roll-In" Metal-Cutting Band Saw

The Universal Vise & Tool Co., Parma, Mich., has just placed on the market a gravity-fed metal-cutting band saw known as the "Roll-In." The saw blade is fed into the work by the gravity-actuated movement of the frame carrying the balanced saw-blade wheels, which is mounted on an inclined track. The pressure with which the blade is fed into the work is automatically regulated by the texture and degree of hardness of the metal being cut, a feature that eliminates blade breakage.

The saw is adaptable for cutting-off, trimming, and contour work. The swivel block for holding the work can be instantly removed when contour or long, straight cuts


Metal-cutting Band Saw with Gravity Feed Made by the Universal Vise & Tool Co.

To obtain additional information on equipment described on this page, see lower part of page 214.



FORTIFY

their hydraulic mechanisms with

HYDRO-DRIVE HYDRAULIC OILS

Those hydraulically operated machines of yours are veterans of the industrial battle front now. They've been working without rest, 24 hours a day, and as they age so rapidly, they need great care and the best of oil.

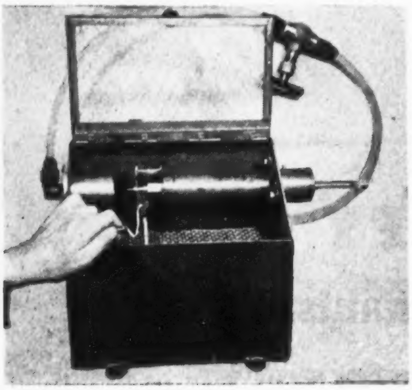
Give them a hydraulic oil that's scientifically fortified three ways—for film strength, for oxidation stability and for gum solvency... an oil that lasts longer, serves better, lengthens the period between oil changes. Give them HYDRO-DRIVE Hydraulic Oil and watch it out-perform ordinary untreated oils used as the hydraulic medium. Write for illustrated booklet.

E. F. HOUGHTON & CO.

303 W. LEHIGH AVE., PHILADELPHIA

Chicago • Detroit • San Francisco • Toronto

are necessary. Saw blades 8 feet 6 inches up to 9 feet in length in three widths of 1/4, 1/2, and 3/4 inch are used. Three speeds, of 81, 161, and 264 feet per minute, are available. The work-table is 18 1/2 by 30 inches. The vertical cutting capacity is 7 inches, and the blade can cut into the work for a depth of 7 inches. Any length of cut can be taken by resetting the work. The equipment includes a work-holding block, a clamping vise, and a 1/2-H.P., 110-volt, 60-cycle alternating-current motor. The machine is 5 feet 2 inches high, 3 feet 4 inches deep, 30 inches wide, and weighs 700 pounds. 67



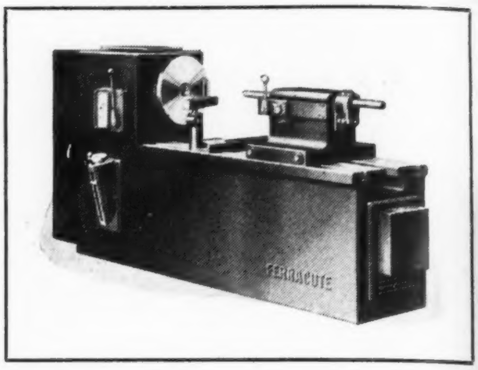
Washing Equipment for Small Bearings, Built by the American Foundry Equipment Co.

Washing Equipment for Small Bearings

To provide for the washing of small ball and roller bearings before assembly in cases where tiny particles of dust, rust, or abrasive matter will prevent the bearings from functioning properly, the Metal Washing Division of the American Foundry Equipment Co., Mishawaka, Ind., has placed on the market a simple but efficient device. This machine is designed to clean and oil bearings individually without exposing them to the room air or handling them, as the latter might result in rust from finger smudges.

The bearing washer consists of a solvent container, a fractional-horsepower solvent pump, a solvent filter, and bearing adapters. An air-hose connection providing clean filtered air can be built into the cleaning unit for removing an excess of solvent. 68

Ferracute Spinning Lathe



Ferracute Metal Spinning, Buffing, and Burnishing Machine

A new spinning lathe known as the 224, designed for performing such operations as spinning, buffing, burnishing, trimming, wiring, and beading at high production rates, has been placed on the market by the Ferracute Machine Co., Bridgeton, N. J. This lathe has a maximum distance between centers of 48 inches, and a maximum swing over the bed of 24 inches. The spindle speed is infinitely variable between 200 and 1000 R.P.M. A 220-440 volt, 60-cycle, three-phase 5-H.P. motor is regularly employed. The motor has two speeds, selected by push-buttons on the motor control panel, and is enclosed in a ventilated compartment. The motor starter, which provides protection from overheating of the motor windings, is of the built-in type.

Instantaneous starting and stopping is accomplished by a single control lever. Once applied, the brake remains on until released by the operator. Air is employed to move the tailstock spindle to the desired position. The maximum travel of the spindle is 12 inches. The hollow spindle has a 3-inch bore and a standard No. 3 Morse taper. The faceplate is keyed on the tapered nose of the spindle. 69

Willey's Carbide-Tool Grinders

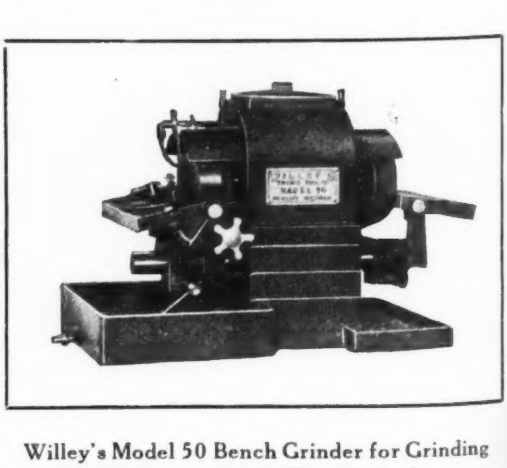
The Willey's Carbide Tool Co., 1340 W. Vernor Highway, Detroit, 16, Mich., has brought out an improved Model 30 carbide-tool grinder, equipped for wet and dry grinding, which is similar in appearance and grinding capacity to the double-end grinder described and illustrated in November, 1942, MACHINERY, page 254. The tool-rest table is 16 by 7 inches, and has an angular adjustment of 30 degrees from the horizontal position. The surface speed of the 8-inch vitrified wheel is about 7000 feet per minute, and that of the 6-inch diamond wheel 5000 feet per minute.

The Model 50 Willey's bench grinder, shown in the accompanying illustration, is a new product of this company designed for rapid, economical wet or dry grinding of tungsten-carbide tipped tools, as well as other types of tool bits, ranging up to a maximum of 1 1/4 inches square or an equivalent cross-sectional area.

The tool-rest table is 6 by 12 inches, and has graduations for accurate setting to any angle from 15 degrees above to 30 degrees below the horizontal position. Coolant is fed by gravity from a reservoir cast in the upper part of the machine. The fully enclosed motor has a speed of 3450 R.P.M. 70

Improved Metal-Cutting Oils

Exhaustive tests in the laboratories of the National Oil Products Co. at Harrison, N. J., have resulted in the development of a series of metal-cutting oils having



Willey's Model 50 Bench Grinder for Grinding Tungsten-carbide Tipped Tools

To obtain additional information on equipment described on this page, see lower part of page 214.

Arm Your Screw Driving Army for SPEED TACTICS

SPEED-UP WITH PHILLIPS SCREWS!

Give your assembly line Phillips Recessed Head Screws and you'll give them the ammunition to clean up lagging assembly jobs on the double-quick!

In most cases, change-overs to Phillips Screws have cut driving time in half! All of the screw driving troubles that slow-up work are eliminated by the Phillips Recessed Head. The scientific recess, by automatically centering the driving force, prevents fumbling, wobbly starts . . . prevents slant-driven screws . . . burred and broken screw heads . . . dangerous screw driver skids.

The Phillips Recess lends "old-hand" skill to the newest newcomer . . . makes fast, faultless driving automatic. It permits power or spiral driving on almost any job.

They cost less to use! Compare the cost of *driving* Phillips with that of slotted head screws. You'll realize that the price of screws is a minor item in your total fastening expense . . . that it actually costs less to have the many advantages of the Phillips Recess!

KEY TO FASTENING SPEED AND ECONOMY

The Phillips Recessed Head was scientifically engineered to afford:

Fast Starting – Driver point automatically centers in the recess . . . fits snugly. Screw and driver "become one unit." Fumbling, wobbly starts are eliminated.

Faster Driving – Spiral and power driving are made practical. Driver won't slip out of recess to injure workers or spoil material. (Average time saving is 50%.)

Easier Driving – Turning power is fully utilized by automatic centering of driver in screw head. Workers maintain speed without tiring.

Better Fastenings – Screws are set-up uniformly tight, without burring or breaking heads. A stronger, neater job results.

PHILLIPS *Recessed Head* SCREWS

WOOD SCREWS • MACHINE SCREWS SELF-TAPPING SCREWS • STOVE BOLTS

21 SOURCES

American Screw Co., Providence, R. I.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
The H. M. Harper Co., Chicago, Ill.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
The Charles Parker Co., Meriden, Conn.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
Reading Screw Co., Norristown, Pa.
Russell Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y.
Scovill Manufacturing Co., Waterville, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
Whitney Screw Corp., Nashua, N. H.

improved characteristics. The oils have been subjected to extended actual plant runs. The objects sought in developing these oils were increased oiliness, copious wetting and cooling capacity, and resistance to rust and corrosion, oxidation, and rancidity. The oils in this new group are known as Vegicut A and Vegicut B—low- and medium-viscosity oils; Vegisol, an emulsified cutting oil soluble in water; and Vegisulph, a sulphurized product providing anti-welding protection. 71

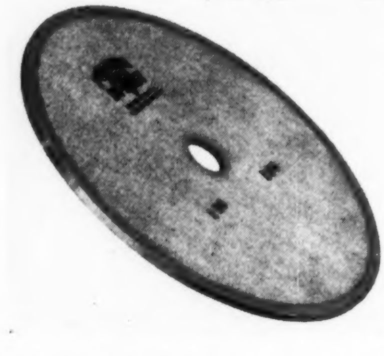
"Ampac" Alternating-Current Welder

An important forward step in alternating-current welding is said to have been made possible by the development of the "Ampac 200" welder just brought out by the Allis-Chalmers Mfg. Co., Milwaukee, Wis. Ideal operating curves that automatically give the correct voltage for the continuous range of currents available are an important feature of this welder. Welding at low currents is made easy with this arrangement and power is saved when welding with high currents.

A new integrated reactor transformer construction provides the high, yet safe, voltage required for easy welding at low currents. Since there is no arc magnetism to cause the arc to wander or weave, welding is easier, especially for inexperienced welders. The job of training new operators is also said to be greatly simplified by the use of this equipment.

"Ampac 200" Welder Brought out by Allis-Chalmers Mfg. Co.

The welding capacity of one machine ranges from 30 to 250 amperes. There is no need to switch welders to accommodate different jobs, because welding rods 1/16 to 1/4 inch in size can be employed for work ranging from thin sheets to heavy plates. Most direct-current welding rods, as well as all alternating-current rods, can be used. 72

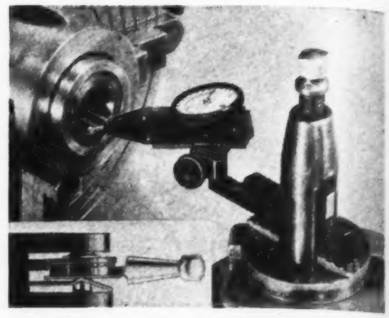


"Di-Met" Wheel Developed by the Felker Mfg. Co.

"Di-Met" Resinoid Wheels

A diamond abrasive chip-breaker wheel known by the trade name "Di-Met" has been developed by the Felker Mfg. Co., 1113 Border Ave., Torrance, Calif. These wheels are made 3, 4, and 6 inches in diameter, with 1/8-inch rim thickness, and are intended for rapidly cutting chip-breaker grooves, and for shaping and form-grinding carbide tips. Similar wheels of thinner construction are available for cut-off operations on carbide inserts.

A new line of "Di-Met" rim-lock diamond abrasive wheels has also been brought out by the company. The new wheels differ from former types in their increased range of thickness, which varies from 1/16 to 1/2 inch. Any width of wheel between these limits is available in diameters of from 1 to 6 inches. The arbor holes are 5/8 inch in diameter, although other sizes can be provided if specified. The wheels are especially intended for the precision cutting, grooving, and facing of hard brittle materials, such as glass, ceramics, porcelain, tile, etc. They are not intended for cutting metal. 73



Federal "Testmaster" Dial Indicator with Enlarged View of Index Point

Federal Universal Dial Indicator

A universal type of dial indicator known as the "Testmaster" is a new product of the Federal Products Corporation, 1144 Eddy St., Providence, R. I. A feature of this indicator is an index point that can be rotated to any angle within a 180-degree arc. Rotation is over ratchet serrations which mesh positively to prevent the point from shifting out of position after being set at the desired angle. The point is hard chromium-plated, and the entire instrument is built for accuracy and extreme sensitivity.

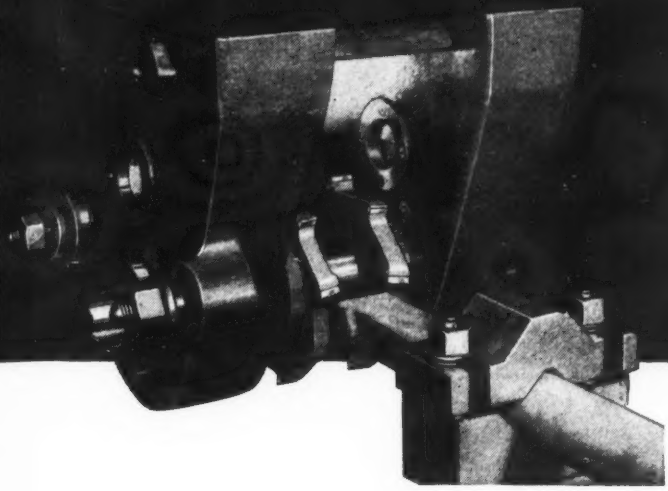
The indicator movement is a simple, direct combination of lever and crown gear, the bearings are jeweled, and a hair-spring takes up all backlash in the gears. Model 1 is graduated in thousandths of an inch and has a range of 0.030 inch, while Model 2 is graduated in tenthousandths of an inch and has a range of 0.008 inch. Two models with metric scales are also obtainable The rotating dial is 1 1/8 inches in diameter, and a holding bar 1/4 by 1/2 by 3 inches long is supplied, together with a universal clamp. 74

"Saw-Gun" Attachment for Electric Drills

An attachment for electric drills, flexible shafts, or compressed air lines, known as a "Saw-Gun," has been brought out by the Mid-States Equipment Co., 2429 S. Michigan Ave., Chicago, Ill. This device is, in effect, a portable power saw or file to be used in panel notching, slotting, or other fabricating operations on plastics, stainless steel, Monel metal, etc. It will cut into wood or plastics without drilling a hole first, and will saw or file plas-

To obtain additional information on equipment described on this page, see lower part of page 214.

The Pioneer Process of Face Milling Steel With Cemented Carbides



The illustration shows two GRAYSON-KENNAMETAL 6" Half-Side Mills, with negative cutting angles, which milled heat-treated 4130 steel at a feed of 19¾"

KENNAMILLING, sometimes referred to as "Hyper-milling" or "Super-milling", was in three-shift operation in the McKenna Metals Company plant as early as April, 1940.

Devised by McKenna engineers, KENNAMILLING has been used for three years by KENNAMETAL customers also, to obtain greatest steel-cutting production on their face milling operations.

Because of the inherent hardness and strength of KENNAMETAL steel-cutting carbide, KENNAMILLING has maintained its leading position despite the entrance of similar processes into the field of face milling with cemented carbides.

The characteristic strength and hardness of KENNAMETAL have been combined with the shock resistant well designed Meehanite bodies of GRAYSON milling cutters to form the most efficient milling cutter available, the GRAYSON - KENNAMETAL milling cutter. Through use of these cutters production is being tripled on operations which demand milling of steel, cast iron, aluminum, aluminum-silicon alloys, magnesium-aluminum alloys, brass, bronze, and non-ferrous materials.

KENNAMILLING With GRAYSON-KENNAMETAL MILLING CUTTERS, HAS THESE ADVANTAGES:

1. GRAYSON-KENNAMETAL milling cutters cut steel at amazingly high speeds.
2. KENNAMILLING is distinguished by greater table feeds and greater load per tooth. (Instead of the customary .001 to .003 the load per tooth during KENNAMILLING is .003 to .016)
3. KENNAMILLING employs negative rake and negative helix angles for maximum cutting efficiency.
4. These double negative rake angles—added to KENNAMETAL'S non-galling properties, hardness, and rupture strength—permit the milling of high Brinell steels.
5. These double negative rake angles also produce a very rugged tool—milling machines have been stopped in the cut without chipping the edges of end mills.
6. KENNAMILLING produces a precision finish.
7. KENNAMILLING is not limited to light cuts.

Write for complete information about KENNAMILLING . . . McKenna Metals Company can give you assistance based on years of face milling production with cemented carbides.

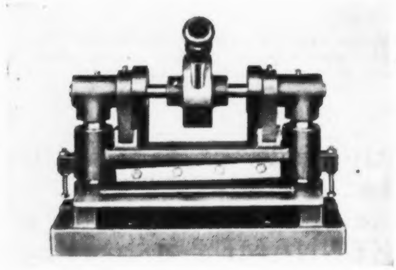
McKENNA METALS Co.
147 Lloyd Ave., Latrobe, Pa.
Foreign Sales: U. S. STEEL EXPORT CO., 30 Church St., New York (Exclusive of Canada and Great Britain)
Trade Mark Reg. U. S. Pat. Off.

KENNAMETAL THE All American CARBIDE

tics, heavy sheet metal, castings, or rods in places that are practically inaccessible with any other tool. 75

Improved Di-Acro Shear

Increased weight and greater mechanical strength and rigidity, combined with easier operation and higher output capacity, are improvements claimed for the new No. 2 Di-Acro shear recently added to the line made by the O'Neil-Irwin Mfg. Co., 332 Eighth Ave., S., Minneapolis, Minn. All the features of versatility and the wide operating range, accuracy, and possibility of working to die



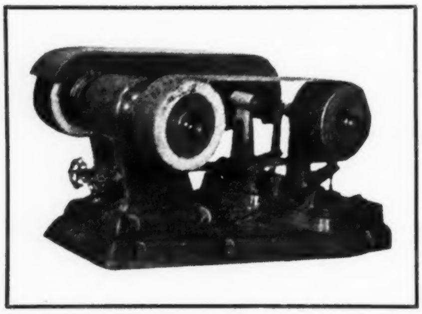
Di-Acro Shear Made by the O'Neil-Irwin Mfg. Co.

tolerances found in the smaller machines of this line have been incorporated in the No. 2 shear.

This shear can be quickly arranged for shearing, slitting, squaring, stripping, or notching to close tolerances. All ductile and pliable metals and materials can be accurately worked, including spring-tempered metals, fabrics, plastics, leather, rubber, and the lightest of tissues. It is especially adapted for developing accurate shapes in bi-metals, sensitized materials, mica, fiber slot insulation, and other dielectrics. Steel plate of 22 gage in widths up to 9 inches can be sheared. The machine weighs about 75 pounds. 76

Jones Bench Grinder

A No. 135 bench grinder and polishing machine has been added to the line of abrasive belt grinding equipment manufactured by the Jones Engineering Co., Ellwood City, Pa. This grinder is designed for fast cutting on production work. It is equipped with an endless abrasive belt, and is



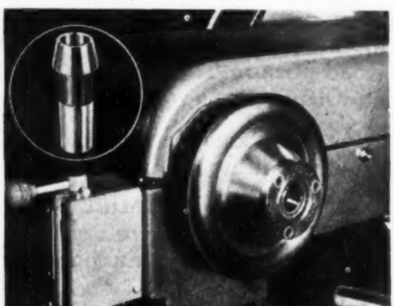
Double Abrasive Belt Grinding and Polishing Machine

particularly adapted for burring, grinding, and finishing flat pieces and irregular-shaped parts.

An adjustable spring tension device on the idler pulley serves to maintain the proper belt tension. The grinder can be used with any 3/4- to 2-H.P. motor. Since the motor is mounted underneath the bench, away from dust and dirt, an enclosed type is not necessary. When two abrasive belts are required—such as a coarse belt for rough-grinding and a fine belt for finishing or polishing—the double bench model grinder No. 136 shown in the accompanying illustration is available. 77

"Speedichuk" and "Bren" Collet for Small Lathes

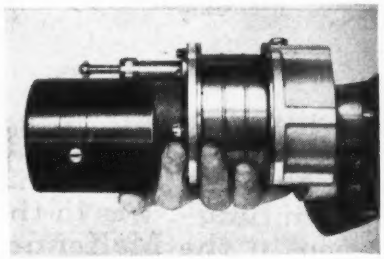
Collets that will hold stock up to 3/4 inch in diameter are now available for small lathes which normally have a capacity of only 1/2 inch. This equipment, known as the "Speedichuk" and the "Bren" collet, has been brought out by the General Die-Stamping-Tool Co., 265 Canal St., New York City. Both the chuck and collet are adaptable to any lathe having a 1 1/2



Chuck and Collet for Small Lathes, Made by General Die-Stamping-Tool Co.

by 8 thread on the spindle nose and a No. 3 Morse taper in the spindle hole. They can also be used on any milling or drilling machine for accurate chucking work, and can be easily fitted to a lathe.

The "Speedichuk" requires no adapter plate, and employs a floating closing sleeve that compensates for wear and misalignment of the lathe spindle. The 6-inch handwheel assures maximum gripping pressure on the collet with minimum effort. The "Bren" collet is designed to permit holding work of any size up to the full diameter of the hole through the spindle. The closing of the collet is accomplished by a squeezing action without longitudinal movement. 78



Midget Variable-speed Drive with Direct-current Motor

Midget Variable-Speed Drive

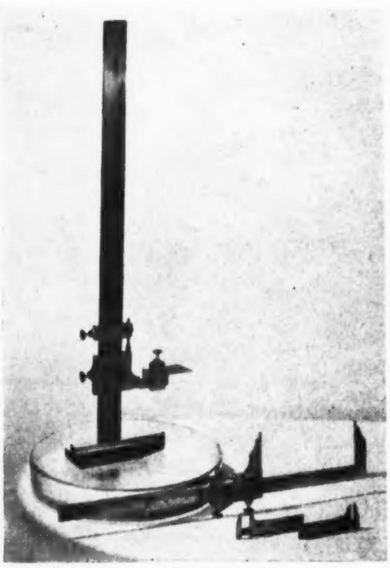
A variable-speed drive weighing only 8 pounds, complete with motor, known as the Graham Model 15, has been added to the line of Graham Transmissions, Inc., 2706 N. Teutonia Ave., Milwaukee 6, Wis. This drive offers the solution to many problems of designers requiring an extremely accurate low-power variable-speed transmission of wide range. The variable-speed unit is applied to motors of not more than 1/15 H.P. The principle of design is identical with that of the larger units made by the manufacturer. The unit is equipped with standard ball bearings.

The output speed range is from 700 R.P.M. to 0, or if it is desired to reverse the output shaft without reversing the motor, the range is from 400 R.P.M. forward to 400 R.P.M. reverse. The instantaneous and shockless reversal is possible because of the low inertia of the parts reversed, which include only the output shaft and gear, the high-speed parts connected to the motor continuing to turn at all

To obtain additional information on equipment described on this page, see lower part of page 214.

times at a constant speed. Various types of controls can be used, including manual operation by handwheel with speed indicating dial located at either side of the unit; lever control; or other special control to suit individual needs.

The length, including input and output shaft extensions, is 7 5/8 inches; the depth, with adjustable mounting legs, is 4 3/8 inches; and the height from base to top of motor is 4 7/8 inches. 79



Precision Vernier Height Gage, Vernier Calipers, and Slide Caliper Made by the McGrath St. Paul Co.

Vernier Height Gage and Calipers

The McGrath St. Paul Co., St. Paul, Minn., is now manufacturing a precision vernier height gage in 10-, 24-, and 36-inch sizes, and vernier calipers in 8-, 12-, and 24-inch sizes. The calipers are designed for both inside and outside measurements. A machinist's 3-inch pocket slide caliper is another new product of this company. 80

* * *

Outside the field of mathematics and the sciences that have mathematics as a basis, so-called logical reasoning is frequently not logical, because too often the object is simply to prove a preconceived conclusion. To do so, the mind adjusts itself to a line of reasoning that is likely to include many irrelevant and erroneous premises.

Steel Threads for Soft Metal Studs

By CAPTAIN BROOKS WALKER
Ordnance Department, Washington, D. C.

A METHOD of providing a steel thread for a stud or cylinder made of soft metal, wood, or other material not generally adapted to threading is shown in the accompanying illustration. The soft metal stud *A* is machined with a shallow thread groove of the required pitch. A hard steel spring *B* of the correct diameter and wire size is screwed on the stud as shown, thus forming a thread for the nut *C*. An enlarged cross-section through the nut, spring, and portion of the stud is shown in the upper view of the illustration. The wire size and depth of groove in the soft stud must, of course, be correct to give a proper thread fit in the nut.

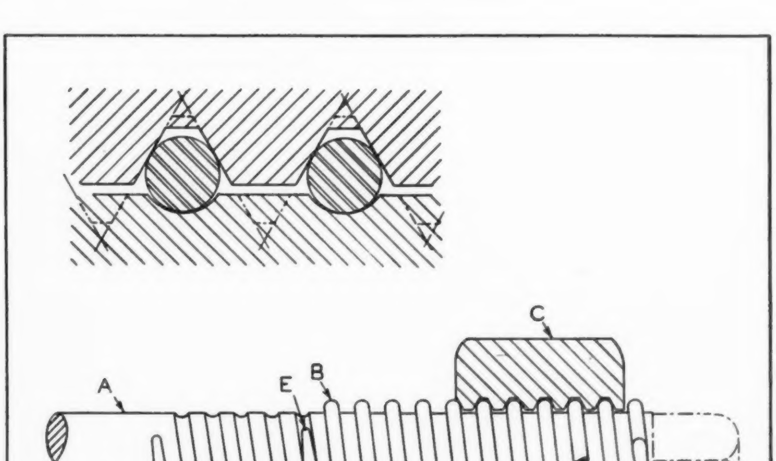
If the end *D* of the spring is fastened to the stud, the nut can be easily turned on the wire thread, but there will be a self-locking effect that will resist removal of the nut if end *E* is not secured to stud *A*. Thus, a lock-nut effect is obtained by leaving end *E* free, so that spring *B* can expand and grip the thread in the nut. Of course, if it is desirable to have the nut turn easily in either direction, both ends *D* and *E* of the spring should be fastened to stud *A*; otherwise the nut must be a very loose fit.

The general idea is not claimed to be new, a somewhat similar arrangement having been previously employed to decrease the wear on threads of spark-plug holes tapped in aluminum. Also, an arrangement of this kind, known as the "Aero-Thread," is shown in the eleventh edition of MACHINERY'S HANDBOOK on page 1311. The latter arrangement employs a patented form with a spring-shaped insert usually made of phosphor-bronze. The device shown in the accompanying illustration, which was developed by the writer, has not been patented, and so far as he is concerned, can be used by anyone.

This construction also lends itself to putting threads in the center of a long bolt, as the spring can be expanded over the bolt to drop in the grooves cut in the center of the shaft, if the grooves are not too deep.

* * *

You cannot establish sound security on borrowed money, nor can you build character and courage by taking away the initiative, responsibility, and independence of the individual.



Method of Using Steel Spring as Thread on Soft Material

To obtain additional information on equipment described on this page, see lower part of page 214.


CHICAGO
THIS IS THE WHEEL* MR. JONES
● Maybe you were stumped by grinding jobs before, but they won't worry you any more.
300 shapes and sizes—every grade and grain—there is a Chicago Mounted Wheel custom-built to take on *any* grinding problem. Each wheel is a whirling point of power that turns your jobs out smooth—and in a hurry.
PROMPT DELIVERY
Action is the keynote from the moment your order comes in. Our wartime set-up concentrates on mounted points and grinding wheels 3" in diameter and under. —Production is stepped up and keeps pace with demand. Another advantage to you is our central location.
NEW CATALOG—Shows Chicago Mounted Wheels in actual colors, also portable electric tools and time-saving accessories.
CHICAGO WHEEL & MFG. COMPANY
America's Headquarters for Mounted Wheels and Small Grinding Wheels.
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☐ Free Wheel. Size..........
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Cutting Large Accurate Keyways on Vertical Shapers

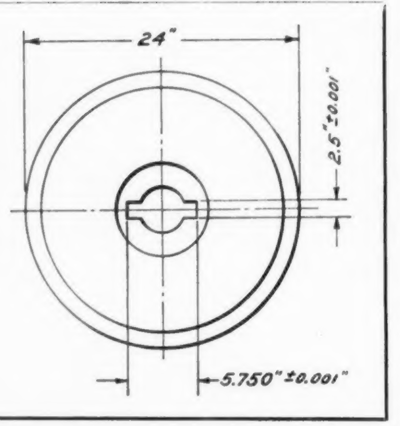


Fig. 1. Details of Deep Keyways Cut on Machine in Fig. 2 without Using Special Tools

THE flexibility of the modern vertical shaper is being used to advantage in machining large keyways in heavy cumbersome pieces. The method of roughing and finishing two 2 1/2- by 3/4-inch keyways, such as shown in Fig. 1, in cylinder barrels used for the hydraulic control of 8-inch guns on a vertical shaper built by the Morey Machine Co., Inc., New York City, is a typical example of such applications. These barrel forgings are about 24 inches in diameter by 10 3/8 inches high, and are made from SAE 4615 steel, normalized and annealed. The vertical shaper, equipped for cutting the keyways in the barrel forgings, is shown in Fig. 2.

A smooth finish is required on the bottom of each keyway, which must be held within 0.001 inch of the exact specified distance from the hole center. The sides of the keyways are also required to have a smooth finish. The keyways must be accurately positioned on the center line of the hole, and must be held to the specified width within the close tolerance indicated in Fig. 1.

One tool is used for the roughing operations and two different tools are used for finishing, one being employed for the bottom, while the other, having two tool bits, is used for finishing the sides. All bits employed for this work are made of Stellite. In practice, it has been found economical to resharpen the tools after finishing ten pieces.

The roughing tool is similar to the bottom-finishing tool, except that its edge is straight. The bottom-finishing tool has a relieved portion in the middle of the cutting edge which leaves two 1/8-inch wide cutting edges projecting that prevent "digging in." A tool of this design has been found to give smoother and more accurate service. This tool, as well as the roughing tool, is given extra support by a rib welded to the tool-holder.

As mentioned, a double-bit tool is used for finishing both sides of the keyway simultaneously. The cutting edges of these tools are kept relatively narrow to insure a good finish. In general, it is found that the longer the tool-holder, the smaller the cutting edge of the tool bit must be in order to insure a smooth, accurate cutting action.

In this case, it has been found more convenient to apply the coolant directly to the cutting points at the top of the stroke by means of two jets. The shaper is set for a stroke of 8 inches, and the roughing operation is performed at the rate of nineteen strokes per minute with a feed of 0.012 inch per stroke. The finishing speed is at the rate of thirty-one strokes per minute with a feed of 0.002 inch per stroke. The time required for cutting the two keyways in a cylinder barrel is six hours.

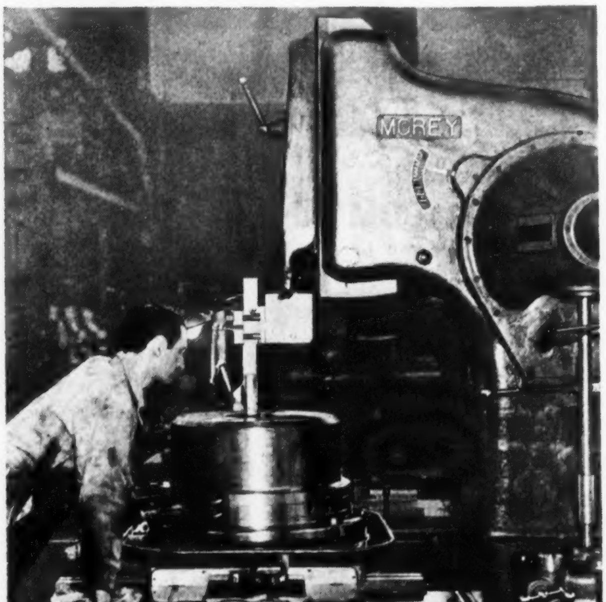


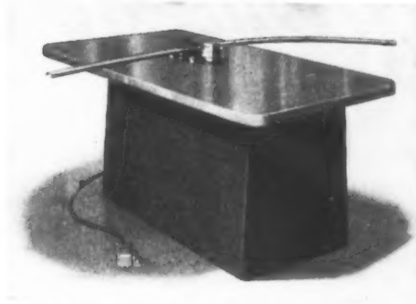
Fig. 2. Morey 14-inch Vertical Shaper Used for Cutting Accurate Keyways in the Cylinder Barrel of 8-inch Guns

* * *

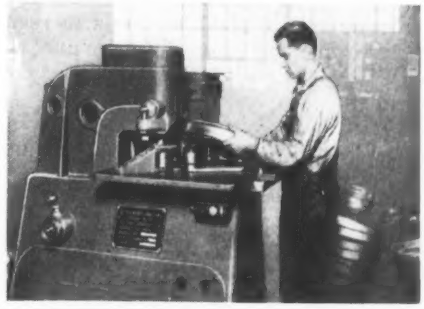
Safety Bulletins

The United States Department of Labor, Division of Labor Standards, has published two bulletins on safety in industrial work. One of these is entitled "A Guide to the Prevention of Weight-Lifting Injuries." This pamphlet can be obtained at a cost of 10 cents from the Superintendent of Documents, U. S. Printing Office, Washington, D. C. Another pamphlet, entitled "Safety Speeds Production — A Message for Supervisors," can be obtained free of charge from the U. S. Department of Labor, Division of Labor Standards. A third pamphlet, entitled "Controlling Absenteeism," is available at 10 cents a copy from the Superintendent of Documents, U. S. Printing Office, Washington, D. C.

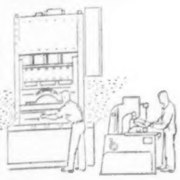
What is the FAST, ACCURATE WAY to TRIM AIRCRAFT STAMPINGS?



Standard Quickwork-Whiting Stamping Trimmer.



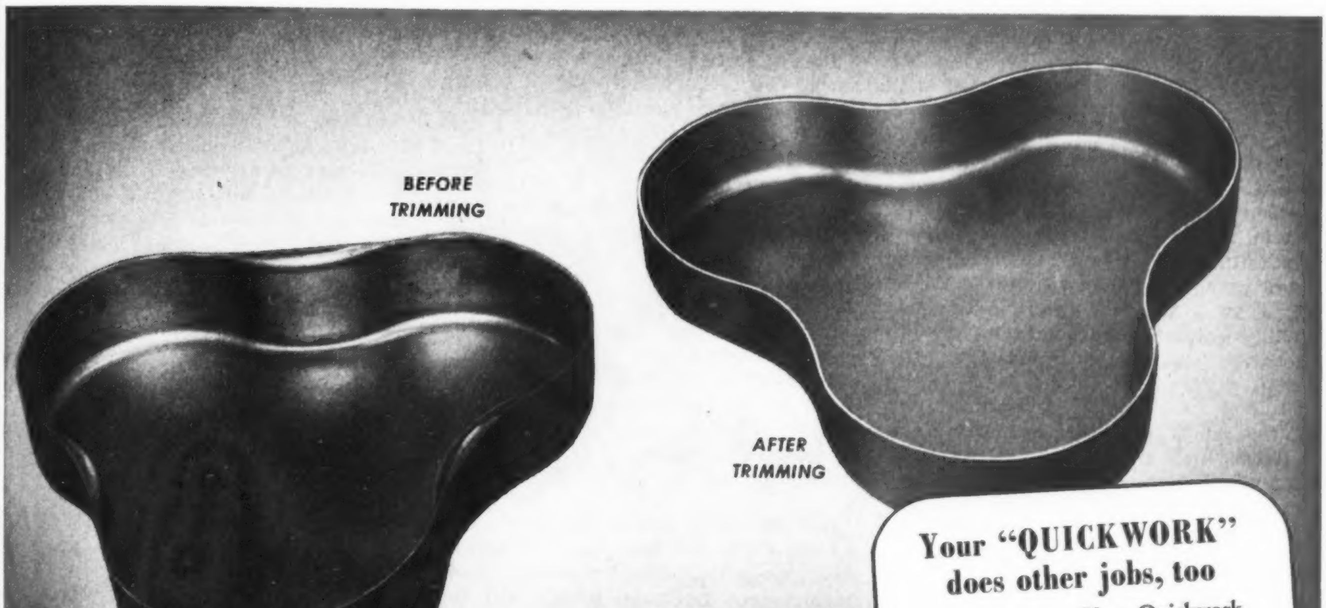
No dies required. Stampings are trimmed accurately in a single pass.



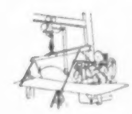
New, unusual, and complicated parts—required by new aircraft designs and other special war equipment —are being trimmed, formed, or both on Quickwork-Whiting Stamping Trimmers.

In many instances, these Quickwork machines have cut to seconds operations that were formerly done by slow, cumbersome methods.

If you have stampings of any kind—stainless, dural, or other alloy—or any shape, investigate Quickwork-Whiting Stamping Trimmers. By releasing presses and operators, and speeding up trimming or forming operations, they can break production bottlenecks in your plant.



Your "QUICKWORK" does other jobs, too



Your Quickwork Shear will also:

- Cut straight lines
- Cut narrow strips
- Cut circles
- Cut openings and irregular shapes
- Cut beveled edges
- Flange and joggle
- Make clean cuts without burrs—in a single pass at high speeds.

Don't wait for a new machine. Use your Quickwork.

ARMY E NAVY

QUICKWORK-WHITING DIVISION

WHITING CORPORATION

15673 LATHROP AVENUE, HARVEY, ILL.

News of the Industry

Illinois

ONSRUD MACHINE WORKS, INC., Chicago, Ill., has recently begun production in a plant built for the production of router bits and cutters of all types and sizes. The new plant multiplies by several times the company's capacity for router bit and cutter production, while at the same time, the capacity for machine production in the main Onsrud plant has been increased by removing the departments that were devoted to the bit and cutter lines.

C. H. WALLACE has been appointed sales manager of the Tolhurst Centrifugal Division of American Machine & Metals, Inc., East Moline, Ill., manufacturers of centrifugal extractors. Mr. Wallace was previously connected with the Norma-Hoffmann Bearings Corporation of Stamford, Conn.

JOHN TJAARDA has become associated with the Accurate Engineering Co., 5248 N. Clark St., Chicago, Ill., designing and research engineers. Mr. Tjaarda was formerly connected with the automobile industry in the capacity of body designer and research engineer.

LEMPCO PRODUCTS, INC., Bedford, Ohio, has purchased the EVANS FLEXIBLE REAMER CO., of Chicago, Ill. The new corporate name will be the EVANS REAMER & MACHINE CO., and the firm will continue operation at its present location—4541 Ravenswood Ave., Chicago.

GEORGE W. PERSON, formerly abrasive engineer in the St. Louis territory for the Norton Co., Worcester, Mass., is now Chicago manager for the Abrasive Division of the Screw Machine Supply Co., Chicago, Ill., one of the Norton Co.'s distributors.

EDWIN B. MCCONVILLE has been elected treasurer of Skilsaw, Inc., Chicago, Ill. Mr. McConville was formerly treasurer of Finch, Van Slyck & McConville, St. Paul, Minn., until he joined the Skilsaw organization as comptroller in 1942.

Michigan

ALBERT V. BEET has been appointed general superintendent of the Arrow Head Steel Products Co., Howell, Mich. Mr. Beet was in charge of this plant from 1915 to 1936, when it was operated under the name of the Spencer-Smith Machine Co. Since that time he has been superintendent of the Canadian plant of Thompson Products, Ltd., St. Catharines, Ontario, and of the Howell Electric Motors Co., Howell, Mich.

TRI-STATE TOOL & GAUGE CO., 19381 John R St., Detroit, Mich., has been formed by GILBERT C. GUYDOS, who for the last eighteen years has been engaged in the aircraft industry in connection with the building of jigs, fixtures, and tools. He has been associated with the Lockheed and Vega aircraft companies, as well as with the Consolidated, North American, and Vultee organizations.

DETROIT ELECTRONIC LABORATORY has been established at 10345 Linwood Ave., Detroit, Mich., to develop and manufacture special-purpose electronic tubes, those now under development being primarily for control equipment for resistance welding. JOHN D. GORDON, formerly general manager of the Taylor-Winfield Corporation, is general manager of the new organization.

BERT CONWAY, who has been connected with the General Motors Corporation for the last twenty-two years, has been named manufacturing coordinator for the Aviation Corporation, Detroit, Mich. Mr. Conway will be in direct charge of the production and tooling at all the corporation's manufacturing plants. His office will be at Detroit.

SMITH, HINCHMAN & GRYLLS, INC., industrial engineers, 666 Penobscot Bldg., Detroit, Mich., have expanded the firm's tool engineering division to include complete engineering service in the manufacturing of war products of different kinds.

DONALD K. BALLMAN has been appointed head of the Dow Chemical Co.'s recently formed Service and Development Division, which will be exclusively concerned with the development of new chemical products for use now and after the war.

M. J. MATTHEWS has been appointed superintendent of the Sheet Metal Division of the Cadillac Motor Car Co., Detroit, Mich.

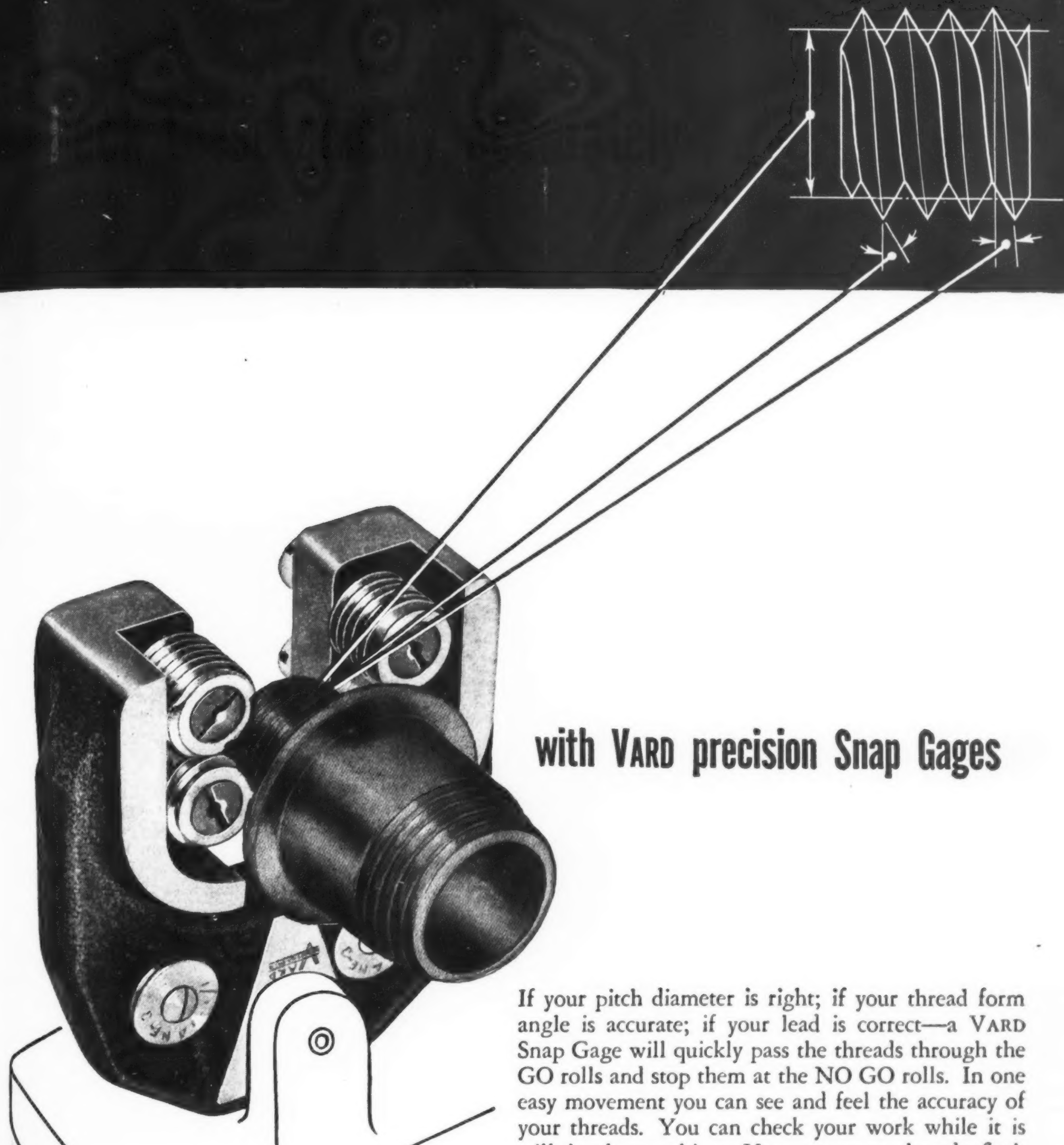
New England

ERNEST REANEY has been elected vice-president in charge of sales and engineering of the O. K. Tool Co., Shelton, Conn. Mr. Reaney has been connected with the company for the last fifteen years.

Ernest Reaney, Newly Elected Vice-president of the O. K. Tool Co.

RAYMOND R. RIDGWAY, associate director of research for the Norton Co., Worcester, Mass., was awarded the Jacob F. Schoellkoph Medal for 1943 at the May 20 meeting of the Western New York Section of the American Chemical Society at Niagara Falls, N. Y. Mr. Ridgway is connected with the Chippawa, Ontario, plant of the Norton Co. He has been connected with the company since 1922, and is

Raymond R. Ridgway, Associate Research Director of the Norton Co., and Recipient of the 1943 Jacob F. Schoellkoph Medal


with VARD precision Snap Gages

recognized as one of the outstanding research men in electrochemistry. His record includes a long list of inventions and improvements in the design of electric furnaces for the production of abrasives. His outstanding accomplishment was the isolation and commercial production of boron carbide, the hardest known material next to the diamond.

EDWARD SHAW, SR., formerly New England sales representative for the Producto Machine Co., Bridgeport, Conn., has joined the Moore Special Tool Co., Inc., also of Bridgeport, as sales manager. Mr. Shaw was associated with the Producto Machine Co. for twenty-eight years, the last fifteen of which were devoted to the New England territory. He will have charge of sales of the Moore jig borer and the Moore jig grinder and of the Tool and Die Division.

New Jersey and New York

STAR ELECTRIC MOTOR CO. and its affiliate, STAR EQUIPMENT CORPORATION, 200 Bloomfield Ave., Bloomfield, N. J., announce the appointment of a new executive staff. The changes were brought about by the death of Carl M. Peterson, co-founder of the company, who served as secretary and treasurer of both organizations, and also as a result of the company's expansion. ELVIN E. HALLANDER has been made first vice-president of both concerns; IVOR C. PETERSON, vice-president in charge of sales; and R. J. GASH, secretary and treasurer. RAYMOND E. HOLLANDER becomes vice-president in charge of planning and purchasing for the motor company, while FRED EBERHARDT becomes vice-president and general manager of the equipment corporation. ELVIN E. HALLANDER, in addition to holding the position of first vice-president, serves as general manager of the motor company. EMIL E. HOLLANDER continues as president.

RONALD S. WALKER has become eastern sales manager for the Stokerunit Corporation, Milwaukee, Wis., with headquarters at 1 Collins Ave., Bloomfield, N. J. Mr. Walker was formerly with the Harrington-Wilson-Brown Co., New York City, and previous to that was with the Barnes Drill Co., Rockford, Ill.

FREDERICK S. ROWE, who joined the Westinghouse Lamp Division, Bloomfield, N. J., as a production clerk, has been appointed manager of electronic-tube production and stocks. WILLIAM J. KNOCHEL has been made assistant superintendent of electronics manufacturing.

GROBET FILE CO. OF AMERICA, manufacturer of rotary files and importer of precision Swiss files, announces that it has more than doubled the factory area of its New York plant at 421 Canal St.

Ohio

CINCINNATI MILLING MACHINE CO., Cincinnati, Ohio, has announced the following executive appointments: MILLARD ROMAINE has returned to the company, following two years' service with the War Production Board, to assume his new duties as assistant to the president. He was formerly sales manager of the company. LESTER F. NENNINGER, engineering department head, has been made works manager, succeeding W. PEASLEE, who recently retired from active service. Mr. Nenninger will be in charge of engineering, works, and production. SWAN E. BERGSTROM, formerly manager of the company's Detroit office, and recently assistant sales manager, has been appointed sales manager.

A. J. WEATHERHEAD, JR., president of the Weatherhead Co., Cleveland, Ohio, was recently presented with a citation for "inventive ingenuity which resulted in war production designs that save large quantities of critical materials, and many machines and man-hours." The citation was presented by Colonel Harold M. Reedall, chief of Cleveland Ordnance District, at a ceremony held at the Weatherhead plant on May 17. Mr. Weatherhead received this honor for his work in connection with steel tubing for primers. He is one of six people throughout the country who have received this citation.

F. M. BEAUREGARD has been appointed works manager of Willys-Overland Motors, Inc., Toledo, Ohio. Mr. Beauregard has had more than twenty-five years' experience in the manufacturing field. For the last two years, he has been general works manager of the Crosley Corporation, Cincinnati, Ohio. Prior to that time, he was associated with the Nash-Kelvinator Corporation for eleven years, and with the Westinghouse Electric & Mfg. Co., at Springfield, Mass., for four years.

CARL H. VAUPEL has been appointed assistant general manager of the Cooper-Bessemer Corporation's two plants, at Mount Vernon, Ohio, and Grove City, Pa. Mr. Vaupel is a graduate of the University of Illinois, 1924. Previous to becoming connected with the Cooper-Bessemer organization, he was with Fairbanks, Morse & Co., the Northern Pump Co., and the Aircraft & Diesel Equipment Corporation. He has been with the Cooper-Bessemer Corporation since 1941.

PRECISION PRODUCTS, INC., is a new concern organized to manufacture precision tools, dies, and small aircraft parts, and to handle accurately tooled small jobs. The president of the company is W. L. Davis, formerly vice-president and general manager of the Romec Pump Co., of Elyria, Ohio. The new organization has acquired the plant, equipment, and personnel of the KRAUSE ENGINEERING CO. at 1876 E. 18th St., Cleveland, Ohio.

RIDGE TOOL CO., Elyria, Ohio, manufacturer of Ridgid pipe tools, has moved from North Ridgeville into a remodeled plant in Elyria which provides five times the working space of the old factory.

WILLARD A. LULI, engineer with the Cooper-Bessemer Corporation for the last eight years, has been promoted to factory production representative for the company's two plants at Mount Vernon, Ohio, and Grove City, Pa.

W. K. COOPER has been named vice-president in charge of sales of the Aviation Corporation, Cleveland, Ohio. His office will be located at 1155 Sixteenth St., N.W., Washington, D. C.

Pennsylvania

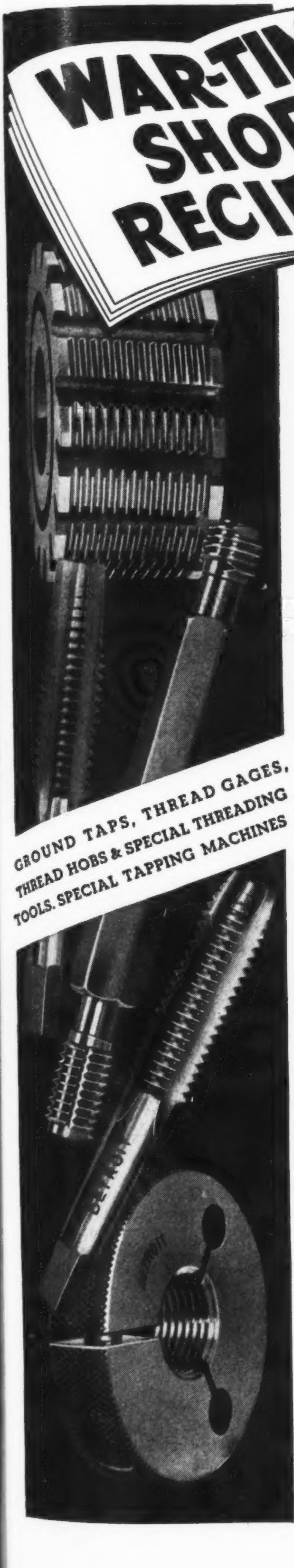
ROBERT R. ZISETTE has been appointed general sales manager of S K F Industries, Inc., Philadelphia, Pa., manufacturers of ball and roller bearings. Mr. Zisette has been connected with the S K F organization since his graduation from Yale University in 1921 with the degree of mechanical engineer. He was previously district manager of the Cincinnati office, and more recently held the position of assistant sales manager.

V. H. PETERSON, for the last two years vice-president of the Elliott Co., has been appointed assistant to the president of the Baldwin Locomotive Works, Philadelphia, Pa. Mr. Peterson graduated from the Rensselaer Polytechnic Institute in 1925 with a degree in mechanical engineering.

A. P. DE SANNO & SON, INC., Phoenixville, Pa., manufacturers of Radiac grinding wheels and abrasive cut-off machines, have opened a new office in Philadelphia, Pa., where a large cut-off laboratory will also be maintained and the company's machines will be exhibited.

LOUIS G. MARINI has been appointed assistant general manager of the Alloy Rods Co., York, Pa. Mr. Marini was formerly process engineer in charge of the production of arc-welding electrodes for the Westinghouse Electric & Mfg. Co. at Trafford, Pa.

MAX PISCHKE has become acting district manager of the Pittsburgh district sales office of the Allegheny



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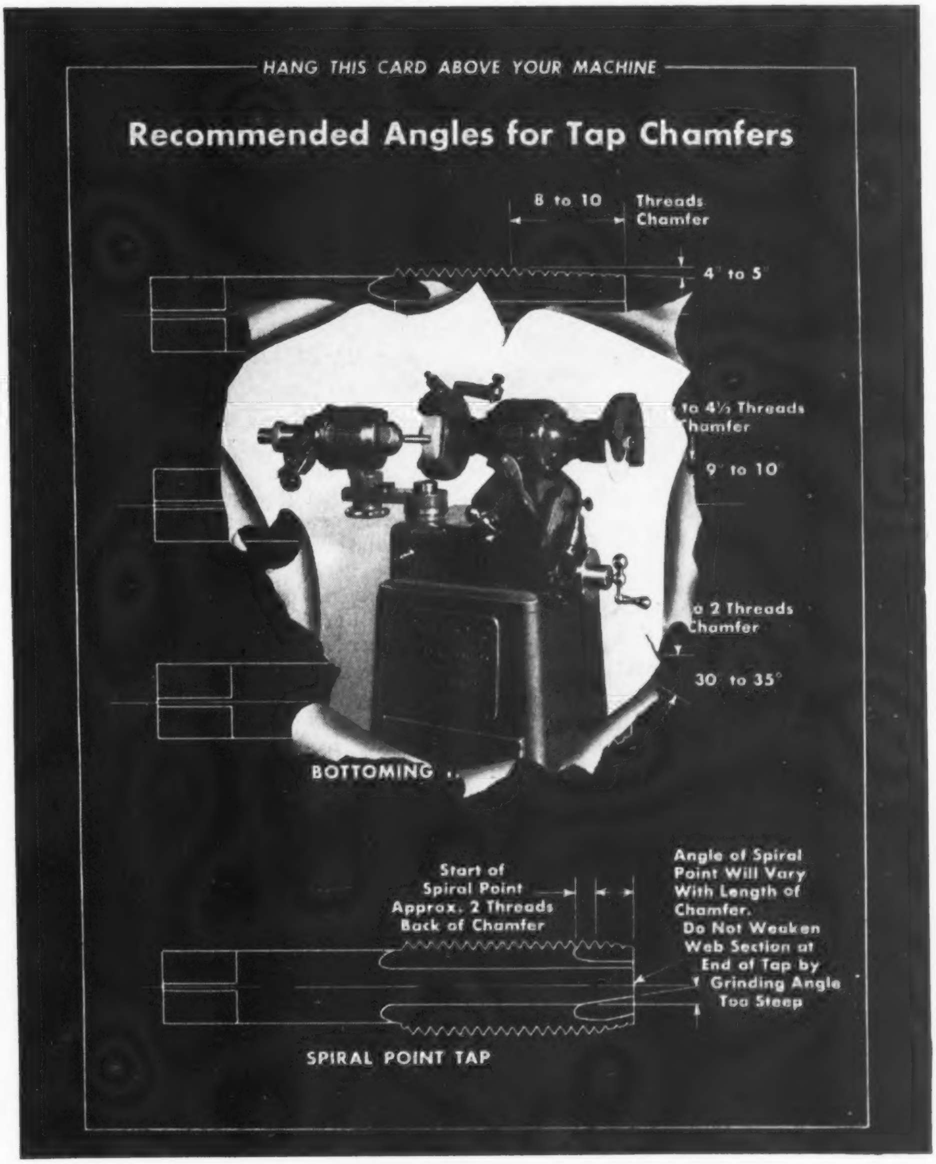

TAKE (1) All your dull or worn taps
(2) "Detroit" Tap reconditioning wall chart, as illustrated
(3) "Detroit" Tap Reconditioner

Then grind taps on the Reconditioner according to instructions on the wall chart and put them back to work — as good as new.

If you don't have a copy of this wall chart, write for one today *on your company letterhead*. Ask for Chart No. RTC.

DETROIT TAP & TOOL CO.

8432 BUTLER STREET, DETROIT, MICHIGAN, U. S. A.

Ludlum Steel Corporation, succeeding ROBERT H. GIBB, former district manager, who has accepted a commission in the U. S. Navy.

MCKENNA METALS Co., 147 Lloyd Ave., Latrobe, Pa., has taken over the sales, engineering, and service of Grayson-Kennametal milling cutters made by the Grayson Mfg. Co.

Wisconsin

C. K. SWAFFORD, works manager and member of the board of directors of the Gisholt Machine Co., Madison, Wis., has been elected a vice-president of that firm. Mr. Swafford entered the employ of the Gisholt organization in 1913. Shortly after the United States entered into the first World War, he left the company, but returned in 1930 as works manager, in which capacity he will also continue to serve.

KEARNEY & TRECKER CORPORATION, Milwaukee, Wis., announces the election of the following officers: J. L. TRECKER, executive vice-president; R. W. BURK, vice-president in charge of sales; E. W. TRECKER, vice-president in charge of manufacturing; J. B. ARMITAGE, vice-president in charge of engineering; FRANCIS J. TRECKER, secretary; and R. L. BISCHOFF, treasurer and assistant secretary.

Coming Events

SEPTEMBER 30 - OCTOBER 2 — Aircraft Engineering and Production Meeting of the SOCIETY OF AUTOMOTIVE ENGINEERS at the Biltmore Hotel, Los Angeles, Calif. John A. C. Warner, secretary and general manager, 29 W. 39th St., New York City.

DECEMBER 6-11—NINETEENTH EXPOSITION OF CHEMICAL INDUSTRIES at the Madison Square Garden, New York City. For further information, address International Exposition Co., 480 Lexington Ave., New York City.

* * *

The extent to which the War Production Board's copper recovery campaign has aided the war effort is indicated by the fact that early in June 197,000,000 pounds of "idle and excessive" copper, both in primary and fabricated forms, had been allocated for war use. The industrial scrap recovery campaign is being continued, since still larger quantities of copper are urgently required.

Obituaries

Earle D. Parker

Earle D. Parker, vice-president and general works manager of the Barber-Colman Co., Rockford, Ill., died suddenly on June 12, following a heart attack, at the age of sixty-three years. Mr. Parker was stricken while working on his farm near Durand, Ill. He had been at his office as usual until noon on Saturday, the day he died.

Mr. Parker was born in Dubuque, Iowa, on December 4, 1879. After graduating from Cornell University with the degree of mechanical engineer, he worked for the Fairbanks Morse Co. in Beloit for two years, after which he became connected with the Barber-Colman Co., with whom he has been associated ever since. He had been general works manager for the last twenty years. Recently he was elected vice-president.

Mr. Parker was a member of the board of directors of the Metal Cutting Tool Institute and a director of the Machinery and Allied Products Institute. He also served on the Advisory Committee on Metal Cutting Tools of the War Production Board, and was active for years in the National Machine Tool Builders Association. He is survived by his widow, a daughter—Mrs. Philip R. Bennett—and two sons, both of whom are in training in the Armed Services.

R. H. CHADWICK, assistant to the manager in charge of engineering at the Fort Wayne Works of the General Electric Co., died on May 29, after a brief illness, aged fifty-one years.

Mr. Chadwick was born in Gardiner, Me., in 1892. He joined the General Electric organization in July, 1912, following his graduation from Brown University with the degree of B.S. in Electrical Engineering. He was enrolled in the "Test" Course at the Fort Wayne Works, and in 1912, entered the Transformer Engineering Department. In 1926, he was appointed engineer of the Transformer Department at Fort Wayne, and continued in that capacity until April, 1941, when he was made assistant to the manager in charge of engineering.

Mr. Chadwick was a member of the American Institute of Electrical Engineers, and had served as president of the Fort Wayne Engineers Club.

MARK HENRY DAMERELL, well known in the forging industry, who for the last twenty-six years was connected with Wyman & Gordon Co., Worcester, Mass., died on May 16. Mr. Damerell was born in 1866 in Ludlow, Mo. He served an apprenticeship in a blacksmith shop, which may account for his later achievements in the forging industry. He was a self-educated type of engineer. In the earlier part of his life, he was connected with the J. I. Case Co., Racine, Wis.; A. O. Smith Corporation, Milwaukee, Wis.; Lansing Drop Forge Co., Lansing, Mich.; and the Studebaker Corporation, South Bend, Ind.

Mr. Damerell was a specialist in forging and in the construction of hammers and hydraulic forging equipment. He also designed a crankshaft twisting machine and a die-cutting machine, and, more recently, a large hydraulic extrusion press.

ALEX OBERHOFFKEN, partner in the Expert Engineering Co., 17498 Mt. Elliott Ave., Detroit, Mich., died on May 11 at the age of sixty-one years. Mr. Oberhoffken was born in Munster, Germany, and studied engineering in that country before coming to the United States in 1904. From 1912 to 1929, he was connected with the Ford Motor Co., in charge of tool design in the Tractor Plant at Dearborn, Mich., where he also served as development engineer. For the next ten years he was connected with the Ingersoll Milling Machine Co., Rockford, Ill. In 1941, he formed, with Eric O. Heinrich, the Expert Engineering Co. He was responsible for many innovations in connection with hydraulic controls.

ROBERT EMERSON BROWN, Pacific Coast division manager of the Electro Metallurgical Sales Corporation, New York City, died on May 26 at Belmont, Calif., at the age of forty-six years. He had been ill for several months. Mr. Brown became connected with the Union Carbide & Carbon Corporation in 1920 at the Electro Metallurgical Co.'s plant in Niagara Falls, N. Y. Later, he was transferred to the Pacific Coast division of this organization, of which he became division manager in 1940. He was a graduate of Lehigh University.

New Books and Publications

The Foreman's Handbook. Edited by Carl Heyel. 410 pages, 5 by 7½ inches. Published by the McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York City. Price, $3.

Foremen who want to make the most of their jobs and prepare themselves for larger responsibilities will be interested in this new reference manual. The contents embrace all phases of the foreman's work—from direct day-to-day responsibilities in handling people and supervising production to the background of economic and management fundamentals. The eighteen chapters, each of which is written by an expert, cover the following subjects: A Breakdown of the Foreman's Job; the Foreman as a Leader; Quality Control and Waste Reduction; Planning and Scheduling; Time Study and Methods Improvement; Cost Control by Foremen; the Foreman's Training Responsibilities; What to Do about Safety; Industrial Fatigue; Special Problems in Supervising Women; Modern Wage-Payment Plans; Job Evaluation; Merit Rating of Employes; the Tools of Industrial Psychology; the Background of Scientific Management; Forms of Industrial Organization; What the Foreman Should Know about Economics; and What the Foreman Should Know about Labor Legislation.

Mechanical Vibrations. By R. K. Bernhard. 139 pages, 6 by 9 inches. Published by the Pitman Publishing Corporation, 2 W. 45th St., New York City. Price, $3.

Because of the trend of engineering development toward increasing speeds and heavier loads involving higher dynamic stresses, the science of mechanical vibrations assumes an ever increasing importance. The aim of this book is to give students and practicing engineers who have not studied dynamics and who are interested in mechanical vibrations an introduction to this important field. It is not the purpose to give a complete treatment of the subject, which would require the application of higher mathematics. The first part of the book discusses physical phenomena and their significance in engineering dynamics. The second part deals with the measuring technique, and describes typical dynamic instruments and testing methods.

A Course in Powder Metallurgy. By Walter J. Baeza. 212 pages, 6 by 9 inches. Published by the Reinhold Publishing Corporation, 330 W. 42nd St., New York City. Price, $3.50.

The interest in the rapidly developing field of powder metallurgy makes a new book on this subject especially timely. This book, written principally for students and instructors, is divided into three sections: The first section contains material comprising a series of lectures on the history of powder metallurgy, modern applications, and laboratory and plant processes. It covers production of metal powders, powder specifications, classification of particle size, cohesion, and manufacturing problems and machines.

The second section gives suggestions for assigning experiments to students. The necessary equipment and materials, together with their cost, are listed. This section should be a useful guide to industrial organizations planning a research or development laboratory. The third section of the book outlines fifteen experiments, each of which can be performed in one or two four-hour laboratory periods.

A. S. T. M. Standards (1942). 1643 pages, 6 by 9 inches. Published by the American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa. Price, $9.

This book of A. S. T. M. standards is published every three years. The 1942 book is issued in three parts, of which this is the first. This part is devoted to ferrous and non-ferrous metals. It covers 355 different standards, including those formally adopted by the Society, as well as tentative standards. The present edition, in view of the war emergency, also includes emergency standards and emergency alternative provisions in A. S. T. M. standards issued in the interest of expediting procurement or conservation of materials. The two other sections of the 1942 book of standards deal with non-metallic materials (constructional) and non-metallic materials (general).

Resistance Welding Manual. 284 pages, 6 by 9 inches. Published by the Resistance Welder Manufacturers' Association, 505 Arch St., Philadelphia, Pa. Price, $2.50.

This welding manual has been prepared to fill the need for an accurate, comprehensive, and practical reference book on resistance welding processes. It covers the fundamental principles of resistance welding; the various types of resistance welding processes; resistance welding machines; controls and timing devices; electrodes, electrode-holders, and conductors; and definitions and symbols.

The Practical Outline of Mechanical Trades for Home Study. Edited by William L. Schaaf. 954 pages, 5 1/2 by 8 1/2 inches. Published by the Garden City Publishing Co., Inc., 14 W. 49th St., New York City. Price, $3.95.

This book has been written with the aim of providing an authoritative reading course of training in the mechanical trades. It covers fourteen subjects, each of which is presented by experienced teachers. The subjects covered include machine shop practice; woodworking and patternmaking; metal trades; electrical trades; trade and mechanical drawing; arithmetic; algebra; practical geometry; shop trigonometry; applied physics; strength of materials; practical chemistry; materials of trade and industry; and machine elements.

Air Navigation for Beginners. By Scott G. Lamb. 103 pages, 5 by 8 inches. Published by the Norman W. Henley Publishing Co., 17 W. 45th St., New York City. Price, $1.50.

This book, written by a retired lieutenant commander of the United States Navy and instructor in navigation in the Air-Mar Navigation Schools of the Franklin Institute of Philadelphia, is intended as a text for secondary schools and individual students starting the study of air navigation. It is designed to provide the students with a preparatory knowledge of the problems later to be encountered in aerial navigation, whether commercial or military.

Combustion-Chamber Design for Oil Engines. By Paul Belyavin. 87 pages, 5 by 7 inches. Published by the Sherwood Press, Box 552, Edgewater Branch, Cleveland, O. Price, $1.50.

This little booklet describes the principles of design of the combustion chamber for oil engines with mechanical injection of fuel. It discusses the basic requirements of design, heat losses during combustion, importance of the correct shape of combustion chamber, efficiency of fuel injection and its influence on combustion, combustion chamber efficiency, and the influence of fuel oil on smoothness of combustion, etc.

Industrial Inspection and Assembly. By Edward N. Whittington. 202 pages, 5 1/2 by 8 inches. Published by the McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York City. Price, $1.75.

This book has been written to serve as a manual for workers in the war industries, as well as for students in vocational high schools and trade schools. The subjects dealt with include general factory procedures, the use of common hand tools, simple mathematics, blueprint reading, lathe operation, inspection procedures and tools, precision instruments, cutting tools, etc.

Classified Contents of This Number

Your Progress Depends Upon Your Knowledge of Your Industry